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BULLETIN OF THE IMPERIAL INSTITUTE

A RECORD OF PROGRESS RELATING TO
AGRICULTURAL, MINERAL AND OTHER
INDUSTRIES, WITH SPECIAL REFERENCE TO
THE UTILISATION OF THE RAW MATERIALS
OF THE DOMINIONS, COLONIES AND INDIA

VOL. XXIX. 1931

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VOL. XXIX. 1931

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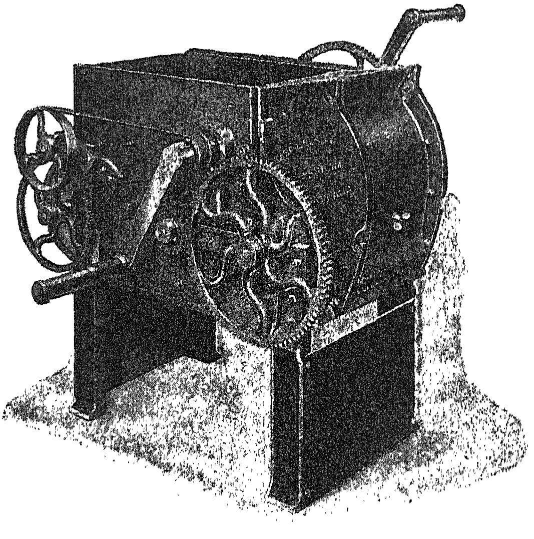

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Under the provisions of the Imperial Institute Act of 1925, the Institute was reorganised and placed under the control of the Department of Overseas Trade. The Parliamentary Secretary of that Department is the responsible Minister and is Chairman of the Board of Governors. This body consists of the High Commissioners of the Dominions and India, representatives of the Colonial Office and of certain other Government Departments, and the Crown Agents for the Colonies, with additional members representing scientific and commercial interests. The Director of the Institute is Lieut.-Gen. Sir William Furse, K.C.B., D.S.O.

The technical work of the Institute is carried out by two principal Departments, viz. a Plant and Animal Products Department and a Mineral Resources Department. An Advisory Council for each of these groups of products has been appointed, Sir David Prain, C.M.G., C.I.E., F.R.S., being Chairman of the Plant and Animal Products Council, and Sir Richard Redmayne, K.C.B., Chairman of the Mineral Resources Council.

A number of Advisory Technical Committees consisting of authorities on the various groups of raw materials co-operate in the work of the Institute, in association with the Advisory Councils, and a close touch is maintained with producers, users, merchants and brokers. Valuable help can thus be given by the Institute to persons interested in the development of the resources of raw materials throughout the Empire.

Intelligence.—The Institute maintains a special service for dealing with enquiries relating to the sources, production, uses and marketing of raw materials and for collecting and disseminating general and statistical information on these subjects. This service is available for the use of individuals and firms, as well as of Government Departments, without charge.

Investigations.—The laboratories of the Institute are specially equipped for the chemical and technical examination of raw materials of all kinds. Full reports are furnished on the composition, uses and value of materials submitted. By its close association with the users of raw materials, the Institute is able to arrange large-scale trials of promising materials when necessary.

Special analyses and investigations are undertaken for firms or private persons in any part of the Empire on payment of appropriate charges. Applications for such investigations should be addressed to the Director.

Investigations on plantation rubber are conducted at the Institute in connection with the Ceylon Rubber Research Scheme.

Library.—The Library of the Institute contains a large collection of Colonial, Indian and other works of reference and is regularly supplied with the more important reports and other publications of Government Departments in Great Britain, the Dominions, Colonies and India, and most foreign countries. More than 500 serial publications, mainly of a scientific or technical character, are also regularly received.

The library is available (free of charge) for the use of enquirers between the hours of 10 a.m. and 5.30 p.m. on week-days (10 a.m. and 1 p.m. on Saturdays).

Statistical Section.—This section is concerned with the collection of statistics for the use of other Departments of the Institute.

Publications.—The BULLETIN OF THE IMPERIAL INSTITUTE contains records of the principal investigations conducted for the Dominions, Colonies and India at the Imperial Institute, and articles and notes, chiefly relating to progress in tropical agriculture and forestry, the development of mineral resources, and the industrial utilisation of all classes of raw materials. A summary of research work conducted by Government Technical Departments overseas and a special bibliography of publications received in the library of the Imperial Institute are also included.

Other publications of the Institute include a series of handbooks dealing with the Commercial Resources of the Tropics, with special reference to West Africa ; Reports of the Indian Trade Enquiry ; a series of Selected Reports on Investigations at the Institute ; a Descriptive List of Some Empire Timbers ; a Monograph on the Tanning Materials of the British Empire ; Monographs dealing with the Mineral Industry of the British Empire and Foreign Countries as well as a statistical series relating thereto ; and a series of volumes on the Mining Laws of the British Empire and Foreign Countries.

Public Exhibition Galleries.—These galleries serve as a permanent exhibition of the natural resources, scenery and life of the people of the Dominions, India and the Colonies. It is the only exhibition of the kind in London where all the countries of the Empire are represented under one roof.

A special feature has been made of pictorial representation, which takes the form of illuminated panoramas, transparencies and photographs. These are intended to attract the non-technical visitor and children, and to awaken in them an interest in the raw products which are shown in association with the illustrations. Descriptive labels are attached to all exhibits explaining in simple language their origin, occurrence, methods of cultivation or preparation, and uses. To render the galleries of further assistance to teachers in the study of Empire geography and development, the exhibits are arranged in a definite sequence on lines suggested by the Advisory Education Committee of the Imperial Institute. Lectures and demonstrations in the galleries are given daily to school teachers and school children by the Guide Lecturers.

At the Central Stand which is maintained in the galleries for enquirers, free literature relating to Empire countries and products is distributed, and other publications and picture postcards are on sale.

In the Exhibition Pavilion, attached to the Galleries, temporary exhibitions of special products are held. The third of these, devoted to Empire minerals, was opened in February 1931.

The galleries are open free daily from 10 a.m. to 5 p.m. and on Sunday afternoons from 2.30 to 6 p.m.

Cinema.—The Empire Marketing Board maintains a Cinema Theatre in the Imperial Institute adjoining the Indian Section in the Exhibition Galleries. The Cinema is equipped with modern projectors, screen, lighting, heating and ventilating systems and has seating accommodation for 400 persons. The cost of this equipment was also borne by the Board. Displays of films illustrating life and industries in the various countries of the Empire are arranged daily at 10.15, 11.35, 2.15 and 3.35 (Sundays 2.45 and 4.15). Special arrangements are made for visits of organised parties from schools and educational institutions. Lectures on industries and countries of the Empire are frequently given in addition to the ordinary cinema displays. The displays and lectures are free.

Imperial Art Gallery.—As a result of negotiations with the Royal Commissioners for the Exhibition of 1851, the upper east gallery has been set aside for exhibition of the works of selected artists from all parts of the Empire. The gallery is also utilised for judging and exhibiting the work of candidates for scholarships at the British School at Rome.

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REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

EMPIRE FIBRES FOR MARINE CORDAGE

AFRICAN SISAL, NEW ZEALAND HEMP AND INDIAN SUNN

The successful development in recent years of the production of Sisal hemp in British countries, especially in Kenya and the mandated territory of Tanganyika, has made it desirable to find new outlets for the fibre, with a view to rendering its extended production remunerative and at the same time displacing to some extent the large quantity of hard fibres (especially Manila hemp) at present obtained from foreign sources. One of the principal uses of Manila hemp is in the manufacture of marine cordage, and as this application would offer a considerable outlet for Sisal if it proved suitable for the purpose, the Imperial Institute decided in 1925 to ascertain whether any justification existed for the prevalent impression that Sisal was unable to withstand the action of sea-water.

The investigations described in the present report were therefore undertaken by the Imperial Institute, under the auspices of its Advisory Committee on Vegetable Fibres, in order to determine the effect of sea-water on the strength and durability of Sisal hemp in comparison with Manila.

Three series of trials have been completed, and the results afford clear evidence that the durability of East African Sisal in sea-water is satisfactory. In general it has been found that the durability of Sisal ropes of No. 1 Brushed East African quality is comparable with that of the Manila ropes used in the trials, which were composed of the following grades : (*a*) J, (*b*) L1 and K in equal proportions, and (*c*) Streaky 3. On the whole the advantage lies with the Manila, but the difference is probably not sufficient to be of practical importance. A rope made from Mexican Henequen which was tested in the second series of trials resisted the action of sea-water to a similar degree to those composed of East African Sisal during the early months of exposure but subsequently suffered rapid deterioration.

In the third series of trials, in addition to the Sisal and Manila ropes, others were introduced composed of New Zealand hemp (Phormium fibre), Indian (Sunn) hemp and Russian hemp.

Promising results were obtained with the ropes made from New Zealand hemp, which proved of equal durability to the best Sisal rope. These ropes, however, had initial tensile strengths lower than the standard demanded by the specification of Government Departments, although that composed of the High Point Fair grade (which represents the bulk of the commercial output from New Zealand) was almost up to this standard.

It is of interest to state that intensive research work is being carried out in New Zealand at Massey College on the breeding and selection of improved strains of Phormium with a view to raising the general standards of strength and productivity. Encouraging results have already been obtained, and samples of improved fibre will be forwarded for official tests in the near future.

The Indian (Sunn) hemp rope was found to be slightly superior to the Russian hemp rope, but both of these proved less resistant to sea-water than ropes made from the hard fibres. These results are of much interest as affording evidence of the inaccuracy of the opinion commonly held in manufacturing and trade circles that Indian (Sunn) hemp is inferior to Russian hemp in its resistance to water, and as confirming the results of trials carried out at the Imperial Institute with twines composed of Indian, Russian and Italian hemps which were published as an appendix to the *Memorandum on Indian* (*Sunn or Sann*) *Hemp* issued by the Empire Marketing Board in 1930.

During the progress of these trials, tests on similar lines have been carried out independently by the Admiralty, who have kindly granted permission for a summary of the results to be published as an appendix to this report. It will be observed that these results confirm those obtained by the Imperial Institute. The Admiralty have also carried out trials with Sisal ropes under service conditions at sea ; encouraging results have been obtained and more extensive tests are being undertaken.

The three series of trials carried out by the Imperial Institute were as follows :

Series I.—The first series of trials was carried out with three 3-inch ropes, composed respectively of (1) East African Sisal, First Quality ; (2) East African Sisal, Unbrushed, Superior No. 2 ; and (3) Manila, J Grade.

Series II.—In arranging for a second series of trials it was decided to employ ropes of 1½ inch circumference as well as 3-inch ropes, and to study the effect not only of the continually repeated immersion of the ropes at each tide (" wet trials "), but also of an intermediate period of exposure to the air between periods of exposure to the sea-water (" wet and dry trials ").

Series III.—In this series it was arranged to employ ropes of one size only (3-inch), and to extend the scope of the investigation by introducing ropes composed of Russian hemp, Indian (Sunn) hemp and New Zealand hemp (Phormium fibre).

Report on Series I

An account of the method of conducting the trials in this series, together with a complete statement of the results obtained and a discussion of their significance, was published in the *Bulletin of the Imperial Institute*, Vol. XXV (1927), No. 4, pp. 359–368.[1]

The results are summarised below, in order to facilitate comparison with those obtained in Series II and III, and are graphically represented in Fig. 1.

Average Breaking Strains (in lb.)

	Sisal No. 1.	Sisal No. 2.	Manila J.
Before exposure to sea-water . .	6,740	8,690	7,920
After 4 months' exposure to sea-water .	4,378	4,250	4,580
„ 6 „ „ „ „ .	3,593	3,463	3,905
„ 9 „ „ „ „ .	3,311	3,063	3,721
„ 12 „ „ „ „ .	2,488	2,181	2,480

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[1] In the report on the first series of trials, observations were recorded regarding the swelling of the ropes on immersion and their subsequent shrinkage on drying. Similar measurements were made in the course of the second and third series, but it was found that under the conditions of these tests the results were not sufficiently concordant to permit the establishment of definite conclusions, and it has therefore been decided not to include them in the present report. Arrangements are being made, however, for a special investigation of these changes.

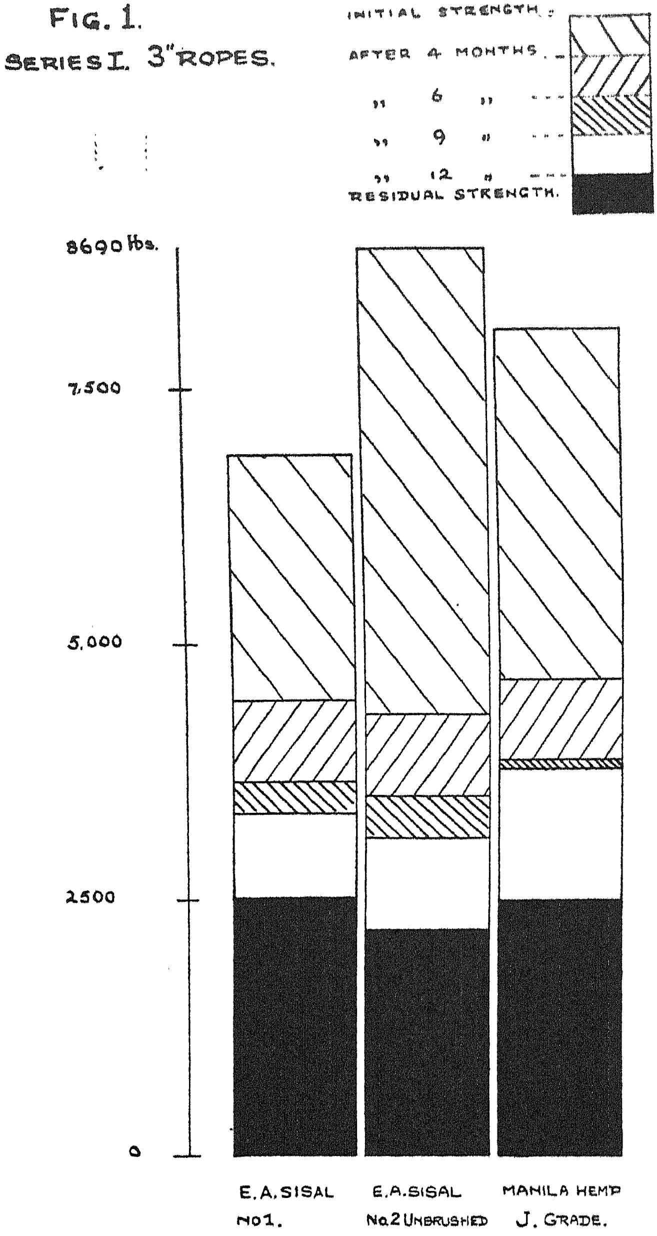

FIG. 1.—Series I. 3-inch ropes.

Percentage Loss in Strength

	Sisal No. 1.	Sisal No. 2.	Manila J.
After 4 months' exposure . . .	35	51	42
„ 6 „ „ . . .	47	60	51
„ 9 „ „ . . .	51	65	53
„ 12 „ „ . . .	63	75	69

Report on Series II

The tests of this series were carried out on 1½-inch and 3-inch ropes made of the following fibres:

East African Sisal.
Manila present grading, L1 and K, equal proportions.
Mexican Henequen.

The ropes were made according to the following specifications drawn up by the late Mr. E. J. Wotton Buckpitt, J.P., Chairman of the Rope, Twine and Net Manufacturers' Federation.

1. Two sizes of rope, viz. 1½-inch and 3-inch.
2. 24-thread yarn.
3. Say 10 or 11 turns per foot for yarn.
4. 1½-inch rope to have 6, and 3-inch rope to have 24, yarns per strand.
5. 1½-inch rope to have 8, and 3-inch rope to have 3½, turns per foot for strand.
6. Both sizes of rope to be 3-strand.
7. 1½-inch rope to have 8, and 3-inch rope to have 4⅓, turns per foot.
8. Nine to 10 fathoms of hard in the strands, but this turn will be taken out when the rope is closed.
9. There should be no "after twist" in the ropes.

"*Wet*" *Trials.*—The ropes were exposed to the action of sea-water by placing them in wooden crates fixed to Southend Pier, in such a position as to ensure that during each tide they were completely submerged for a period, and completely uncovered for a period.

"*Wet and Dry*" *Trials.*—The ropes, after being exposed to the conditions described above, were removed to a dry position on the upper deck of the pier where they were exposed to the air but protected from rain. They were subsequently replaced in the crates and exposed to sea-water for a further period.

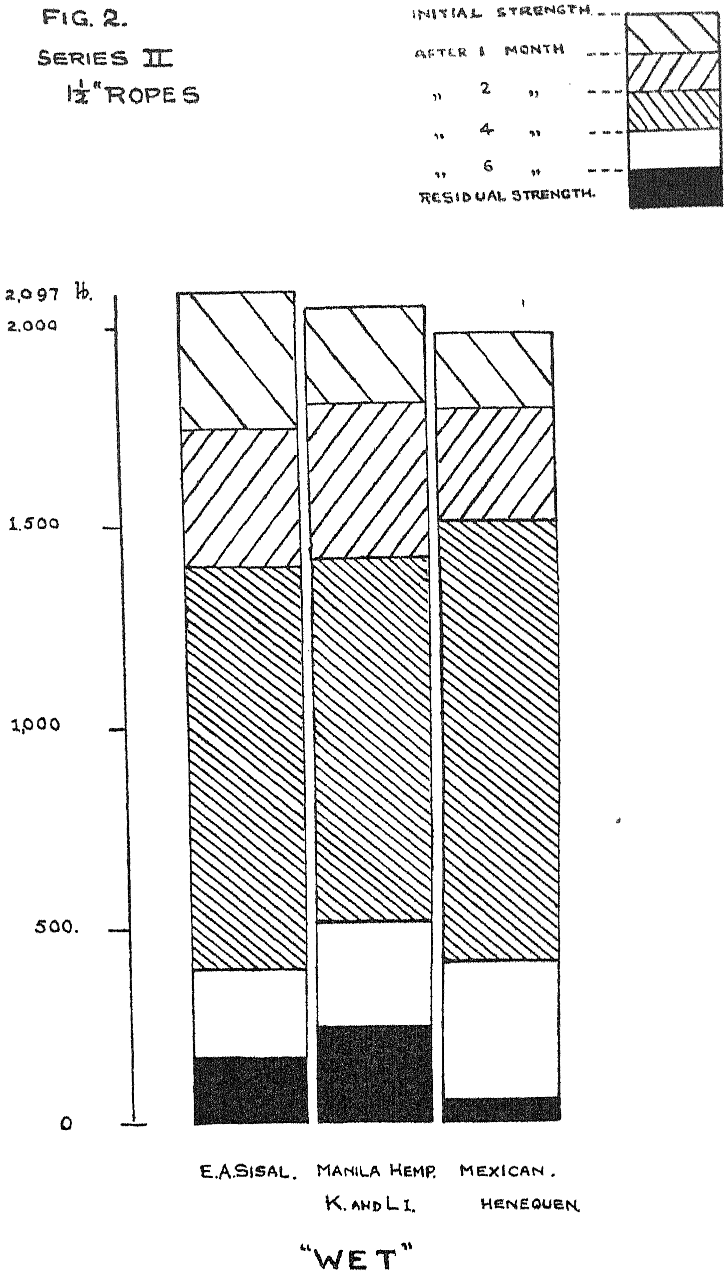

FIG. 2.—Series II. 1½-inch ropes.

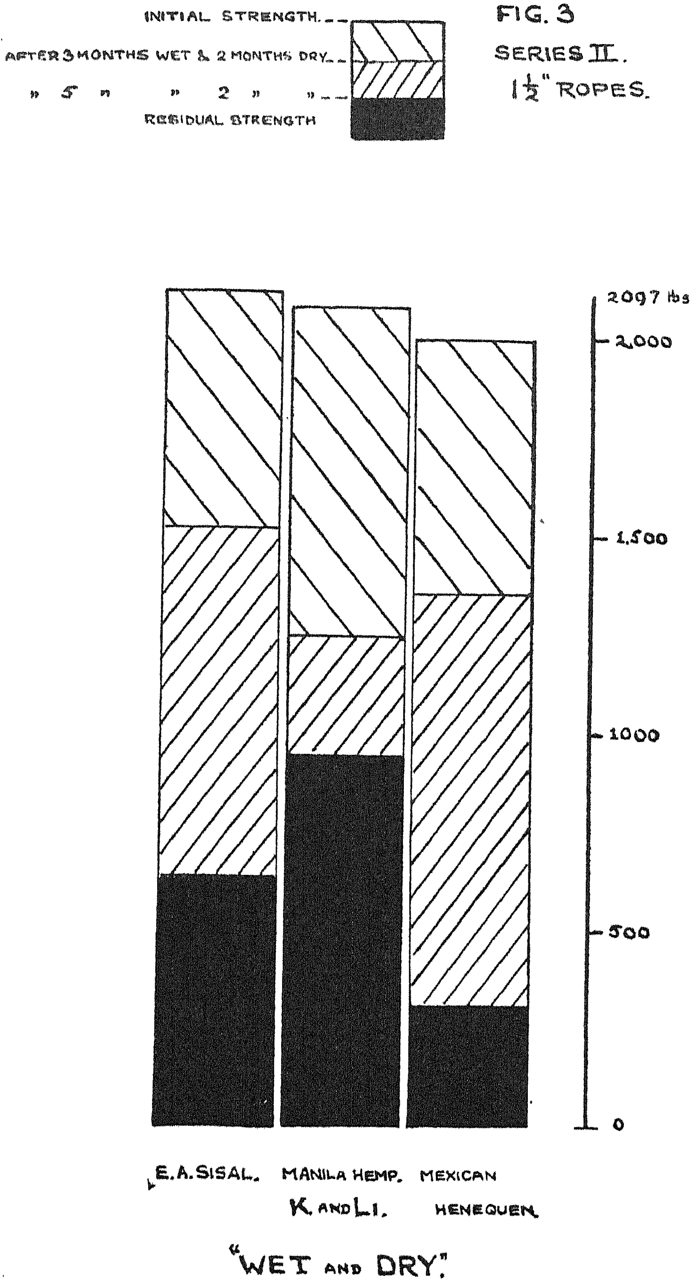

FIG. 3.—Series II. 1½-inch ropes.

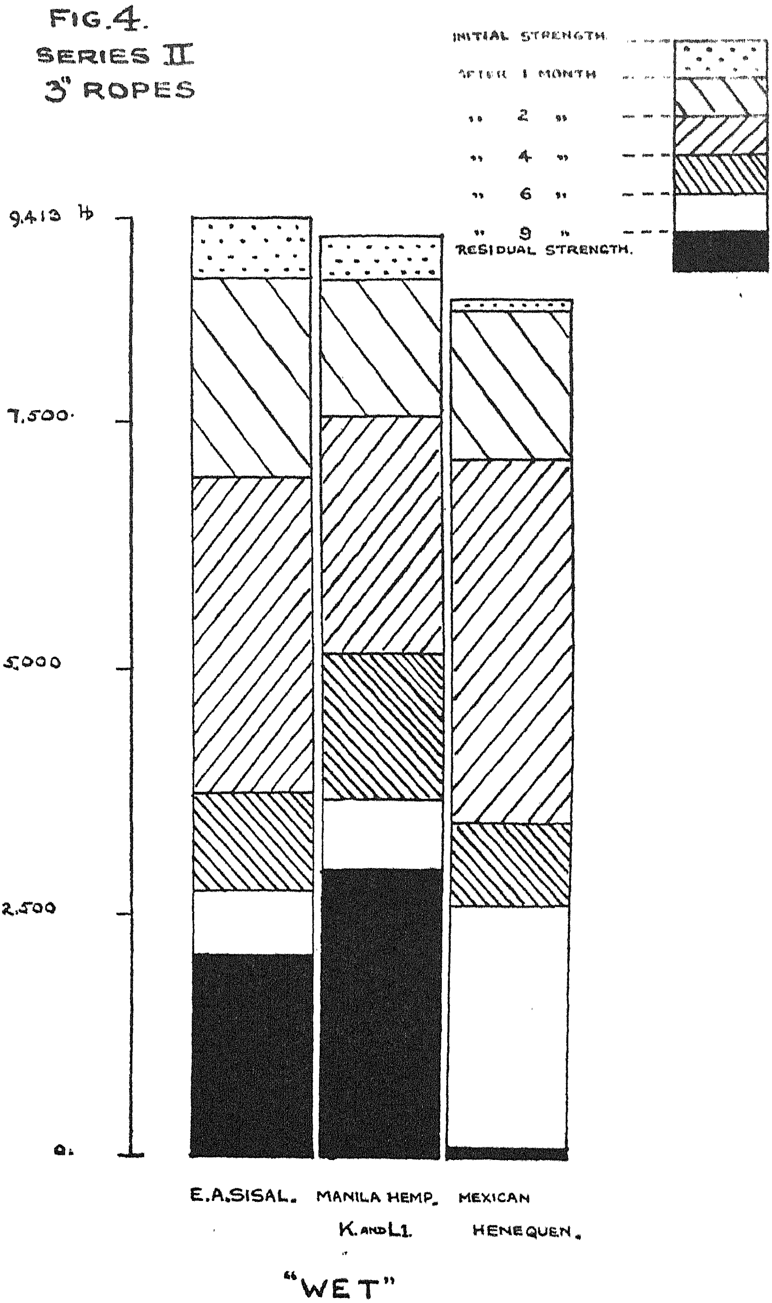

Fig. 4.—Series II. 3-inch ropes.

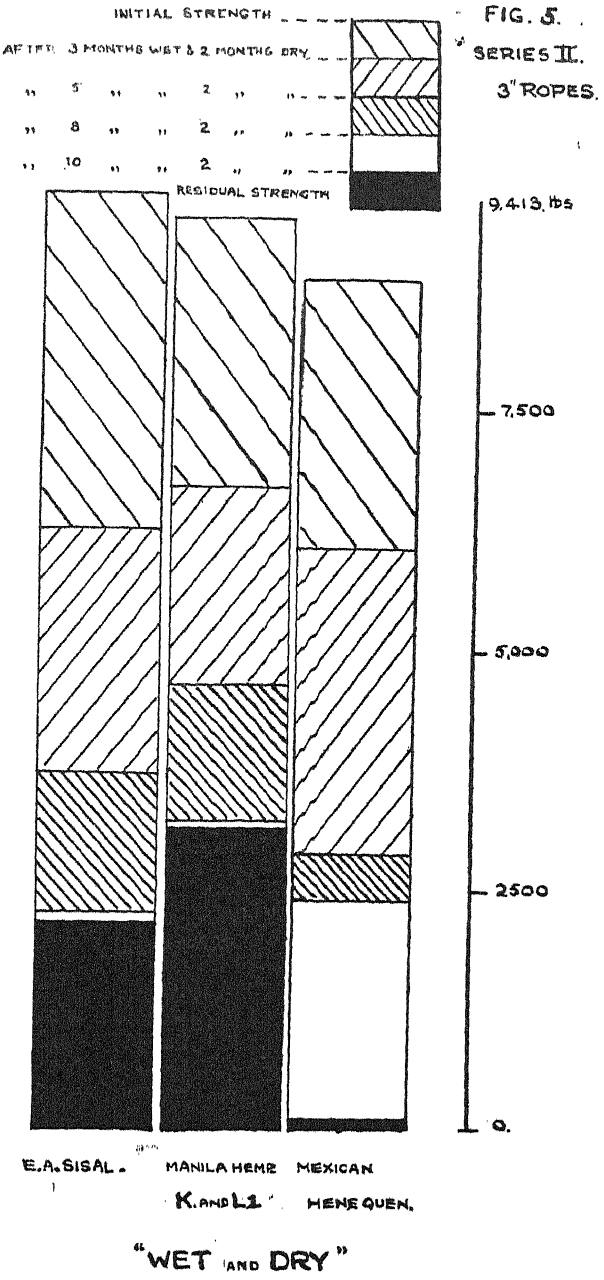

FIG. 5.—Series II. 3-inch ropes.

In order that the ropes might be in the same condition in the tensile tests with regard to humidity, all the test pieces were thoroughly washed with fresh water and tested in an air-dry condition.

The determination of the breaking strains of the ropes was made by means of a Riehlé machine, the method of attachment being made by grips, which has proved more satisfactory than either splicing an eyelet or using a bollard.

The results obtained are given in the following tables and are represented graphically in Figs. 2–5.

Results of Tests with 1½-inch Ropes

Breaking Strain before Immersion

	Sisal.	Manila.	Henequen.
	lb.	*lb.*	*lb.*
	2,110	2,090	2,000
	2,100	2,170	2,000
	2,090	2,000	1,990
	2,090	1,980	2,010
	2,090	2,150	1,990
	2,100	1,980	1,990
Average .	2,097	2,062	1,997
Range .	2,090–2,110	1,980–2,170	1,990–2,010
Variation .	20	190	20

(*a*) *"Wet" Trials*

Breaking Strain after 1 Month's Immersion in Sea-water

	Sisal.	Manila.	Henequen.
	lb.	*lb.*	*lb.*
	1,980	1,700	1,840
	1,600	1,890	1,800
	1,700	1,900	1,780
	1,710	1,890	1,830
	1,790	1,730	1,780
	1,750	1,830	1,770
Average .	1,755	1,823	1,800
Range .	1,600–1,980	1,700–1,900	1,770–1,840
Variation .	380	200	70

Breaking Strain after 2 Months' Immersion in Sea-water

	Sisal.	Manila.	Henequen.
	lb.	*lb.*	*lb.*
	1,310	1,510	1,500
	1,450	1,340	1,550
	1,350	1,370	1,520
	1,480	1,540	1,560
	1,460	1,350	1,470
	1,400	1,450	1,500
Average .	1,408	1,427	1,517
Range .	1,310–1,480	1,340–1,540	1,470–1,560
Variation .	170	200	90

Breaking Strain after 4 Months' Immersion in Sea-water

	Sisal. *lb.*	Manila. *lb.*	Henequen. *lb.*
	330	540	350
	500	570	370
	490	580	330
	310	480	370
	210	600	430
	500	540	530
Average .	390	552	397
Range .	210–500	480–600	330–530
Variation .	290	120	200

Breaking Strain after 6 Months' Immersion in Sea-water

	Sisal. *lb.*	Manila. *lb.*	Henequen. *lb.*
	140	240	70
	170	270	80
	160	240	60
	150	220	70
	140	240	50
	190	230	50
Average .	158	240	63
Range .	140–190	220–270	50–80
Variation .	50	50	30

(b) "Wet and Dry" Trials

3 Months Wet and 2 Months Dry

In the following trials the ropes were in water for 2 months, in the air for 2 months and again in the water for 1 month.

Breaking Strain

	Sisal. *lb.*	Manila. *lb.*	Henequen. *lb.*
	1,360	1,550	1,390
	1,500	1,250	1,310
	1,660	1,100	1,290
	1,350	1,200	1,380
	1,540	1,140	1,360
	1,690	1,250	1,390
Average .	1,517	1,248	1,353
Range .	1,350–1,690	1,100–1,550	1,290–1,390
Variation .	340	450	100

5 Months Wet and 2 Months Dry

In the following trials the ropes were in water for 2 months, in the air for 2 months and again in the water for 3 months.

Breaking Strain

	Sisal. *lb.*	Manila. *lb.*	Henequen. *lb.*
	640	970	200
	670	1,000	310
	600	910	280
	650	930	290
	600	940	380
	630	950	390
Average .	632	950	308
Range .	600–670	910–1,000	200–390
Variation .	70	90	190

8 *Months Wet and* 2 *Months Dry*

In trials in which the ropes were in water for 6 months, in the air for 2 months and again in the water for 2 months the ropes became too weak to allow of satisfactory determination of the breaking strain.

RESULTS OF TESTS WITH 3-INCH ROPES

Breaking Strain before Immersion

	Sisal. *lb.*	Manila. *lb.*	Henequen. *lb.*
	9,840	9,100	8,450
	9,270	9,210	8,810
	9,270	9,190	8,490
	9,770	9,170	9,000
	9,220	9,230	8,350
	9,110	9,170	8,350
Average .	9,413	9,178	8,575
Range .	9,110–9,840	9,100–9,230	8,350–9,000
Variation .	730	130	650

(*a*) "*Wet*" *Trials*

Breaking Strain after 1 *Month's Immersion in Sea-water*

	Sisal. *lb.*	Manila. *lb.*	Henequen. *lb.*
	8,200	9,030	8,990
	8,000	8,640	8,780
	10,010	9,000	8,320
	9,670	8,610	8,570
	8,670	8,960	8,000
	8,130	8,390	8,390
Average .	8,780	8,772	8,508
Range .	8,000–10,010	8,390–9,030	8,000–8,990
Variation .	2,010	640	990

Breaking Strain after 2 *Months' Immersion in Sea-water*

	Sisal. *lb.*	Manila. *lb.*	Henequen. *lb.*
	7,360	7,640	7,160
	6,820	6,900	6,660
	6,740	6,950	6,610
	7,060	7,060	7,110
	6,310	8,000	7,240
	6,530	7,770	7,080
Average	6,803	7,387	6,977
Range	6,310–7,360	6,900–8,000	6,610–7,240
Variation	1,050	1,100	630

Breaking Strain after 4 *Months' Immersion in Sea-water*

	Sisal. *lb.*	Manila. *lb.*	Henequen. *lb.*
	3,140	5,070	3,170
	3,510	5,130	3,070
	3,730	5,040	3,280
	3,830	5,000	3,360
	3,900	5,010	3,800
	3,780	4,990	3,330
Average	3,648	5,040	3,335
Range	3,140–3,900	4,990–5,130	3,070–3,800
Variation	760	140	730

Breaking Strain after 6 *Months' Immersion in Sea-water*

	Sisal. *lb.*	Manila. *lb.*	Henequen. *lb.*
	2,950	3,550	2,630
	2,460	3,710	2,600
	2,680	3,850	2,350
	2,800	3,170	2,680
	2,470	3,590	2,560
	2,660	3,850	2,430
Average	2,670	3,620	2,542
Range	2,460–2,950	3,170–3,850	2,350–2,680
Variation	490	680	330

Breaking Strain after 12 *Months' Immersion in Sea-water*

	Sisal. *lb.*	Manila. *lb.*	Henequen. *lb.*
	2,100	2,700	Rope too weak for testing.
	2,000	3,300	
	1,990	2,840	
	2,050	2,800	
	1,980	3,000	
	2,150	2,790	
Average	2,045	2,905	
Range	1,980–2,150	2,700–3,300	
Variation	170	600	

(*b*) "*Wet and Dry*" *Trials*

3 *Months Wet and* 2 *Months Dry*

In the following trials the ropes were in water for 2 months, in the air for 2 months and again in the water for 1 month.

Breaking Strain

	Sisal. *lb.*	Manila. *lb.*	Henequen. *lb.*
	5,820	6,300	5,590
	6,110	6,230	5,750
	5,970	6,690	5,640
	6,100	6,300	6,220
	5,920	6,740	6,320
	6,580	6,650	5,970
Average .	6,083	6,485	5,915
Range .	5,820–6,580	6,230–6,740	5,590–6,320
Variation .	760	510	730

5 *Months Wet and* 2 *Months Dry*

In the following trials the ropes were in water for 4 months, in the air for 2 months and again in the water for 1 month.

Breaking Strain

	Sisal. *lb.*	Manila. *lb.*	Henequen. *lb.*
	3,590	4,570	2,690
	3,530	4,330	2,750
	3,420	4,660	2,980
	3,360	4,400	2,840
	3,790	4,420	2,670
	3,790	4,560	2,980
Average .	3,580	4,490	2,818
Range .	3,360–3,790	4,330–4,660	2,670–2,980
Variation .	430	330	310

8 *Months Wet and* 2 *Months Dry*

In the following trials the ropes were in water for 6 months, in the air for 1 month, in water for 1 month, in the air for 1 month and again in water for 1 month.

Breaking Strain

	Sisal. *lb.*	Manila. *lb.*	Henequen. *lb.*
	2,170	2,660	2,260
	1,810	3,000	2,420
	2,300	3,230	2,370
	2,180	3,010	2,400
	2,300	3,300	2,200
	2,420	3,680	2,160
Average .	2,197	3,147	2,302
Range .	1,810–2,420	2,660–3,680	2,160–2,420
Variation .	610	1,020	260

10 *Months Wet and* 2 *Months Dry*

In the following trials the ropes were in water for 7 months, in the air for 1 month, in water for 1 month, in the air for 1 month and again in the water for 2 months.

Breaking Strain

	Sisal. *lb.*	Manila. *lb.*	Henequen. *lb.*
	2,100	3,240	Rope too weak for testing.
	2,030	3,200	
	2,210	3,270	
	2,300	2,980	
	1,980	2,880	
	1,990	3,030	
Average .	2,102	3,100	
Range .	1,980–2,300	2,880–3,270	
Variation .	320	390	

SUMMARY

Percentage Loss in Strength

In the following table the decrease in average strength shown by each rope in the experiments now recorded is expressed as a percentage of the original strength of the rope.

(*a*) "*Wet*" *Series*

1½-*inch Ropes*

Months.	Sisal.	Manila.	Henequen.
1 (November)	16·3	11·6	9·9
2 (November and December) .	32·9	30·8	24·0
4 (May to August) . . .	81·4	73·2	80·1
6 (May to October) . . .	92·4	88·3	96·8
12 (May to April) . . .	(The ropes were now too weak for satisfactory test.)		

3-inch Ropes

Months.	Sisal.	Manila.	Henequen.
1 (November)	6·7	4·4	0·8
2 (November and December)	27·7	19·5	18·6
4 (May to August)	61·2	45·1	61·1
6 (May to October)	71·6	60·5	70·3
12 (May to April)	78·3	68·4	Too weak for satisfactory test.

(*b*) "*Wet and Dry*" *Series*

1½-inch Ropes

Months.		Sisal.	Manila.	Henequen
In Water:	In Air:			
3 (May, June; September)	2 (July, August)	27·6	39·5	32·2
5 (May, June; September, October, November)	2 (July, August)	69·8	53·9	—
5 (May, June, July, August; November)	2 (September, October)	—	—	84·6
8 (May to October; December; February)	2 (November; January)	Too weak for satisfactory test.		
10 (May to November; January; March, April)	2 (December; February)			

3-inch Ropes

Months.		Sisal.	Manila.	Henequen.
In Water:	In Air:			
3 (May, June; September)	2 (July, August)	35·4	29·4	31·0
5 (May, June, July, August; November)	2 (September, October)	61·9	51·1	67·1
8 (May to October; December; February)	2 (November; January)	76·6	65·7	73·2
10 (May to November; January; March, April)	2 (December; February)	77·7	66·2	Too weak for satisfactory test.

CONCLUSIONS ON SERIES II

In considering the results of these experiments, it will be observed that in each size of ropes (1½-inch and 3-inch) the Manila rope generally proved rather more resistant than the Sisal and Henequen ropes. The Sisal and Henequen ropes behaved very similarly to one another, except that towards the end of each experiment the Henequen underwent rapid disintegration.

"*Wet*" *Tests.*—In the case of the 1½-inch ropes the rate of deterioration of the Sisal and Manila was very similar, the advantage shown by the latter being too small to be of practical significance.

In the case of 3-inch ropes the Manila rope again showed a somewhat greater durability than the Sisal rope, the superiority in this case being rather more marked than in the case of the 1½-inch ropes.

"*Wet and Dry*" *Tests.*—These tests gave more irregular results than the "wet" tests. In the case of the 1½-inch ropes the Sisal rope showed less deterioration than the Manila after 3 months' exposure to water and 2 months in the air, whereas after 5 months' exposure to water and 2 months in the air, the Manila rope had apparently suffered less than the Sisal.

In the case of the 3-inch ropes, however, the difference between the behaviour of the Sisal and Manila ropes was very similar to their behaviour in the "wet" tests.

In general, the relative behaviour of the ropes in the "wet and dry" tests was similar to their behaviour in the "wet" tests.

Report on Series III

The tests of Series III were carried out with samples of 3-inch ropes, made according to Mr. Buckpitt's specifications (see page 5) from the following fibres:

Rope No.	Fibre of which composed.
1	Sisal No. 1 Brushed.
2	Sisal No. 1 Unbrushed.
3	Sisal No. 2 Brushed.
4	Sisal No. 2 Unbrushed.
5	Manila Streaky 3.
6	Russian Dressed Siretz, No. 2 Grade, No. 2 quality.
7	Indian Dressed.
8	New Zealand Fair.
9	New Zealand High Point Fair.
10	New Zealand Good Fair (Special).
11	New Zealand High Point Fair (Special).

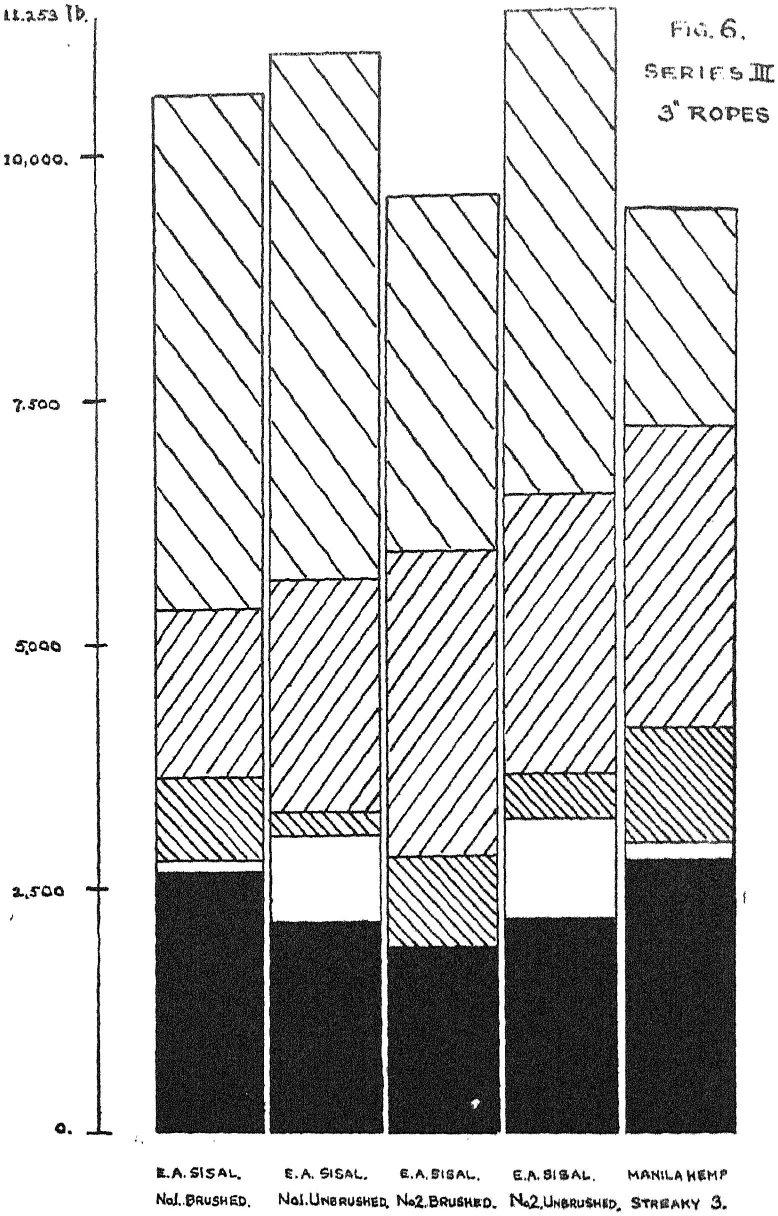

Fig. 6.—Series III. 3-inch ropes.
(For Key to this Chart see Fig. 7.)

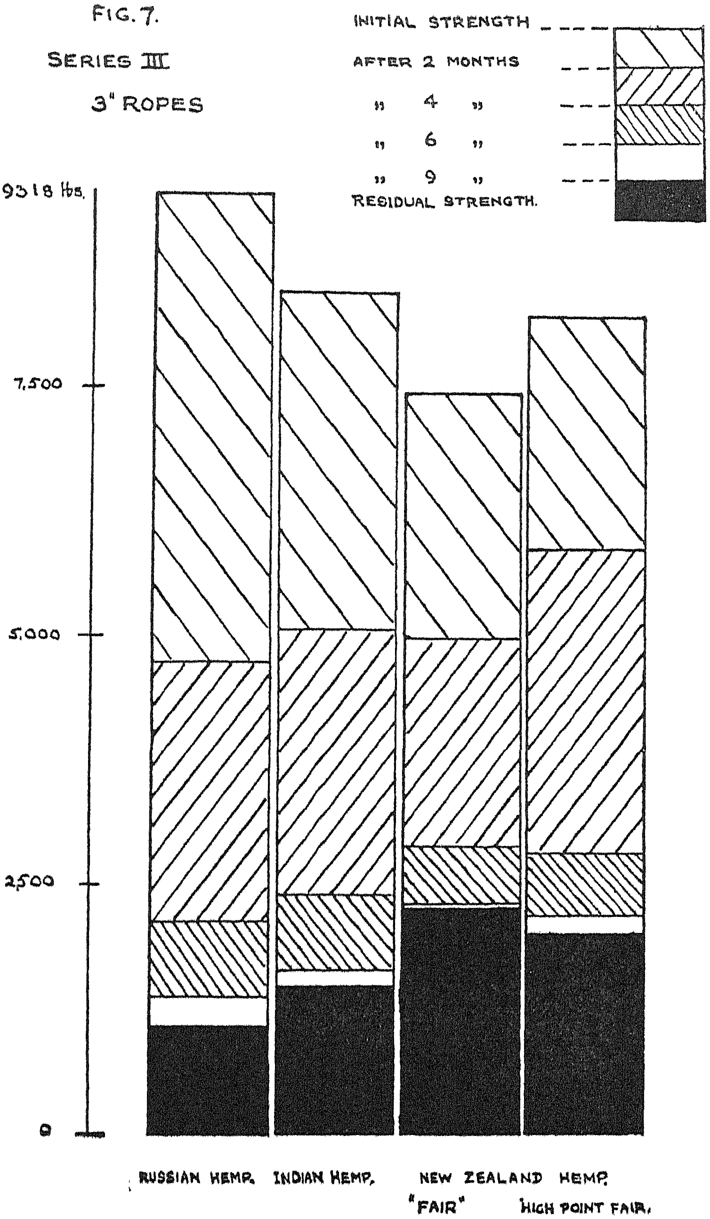

Fig. 7.—Series III. 3-inch ropes.

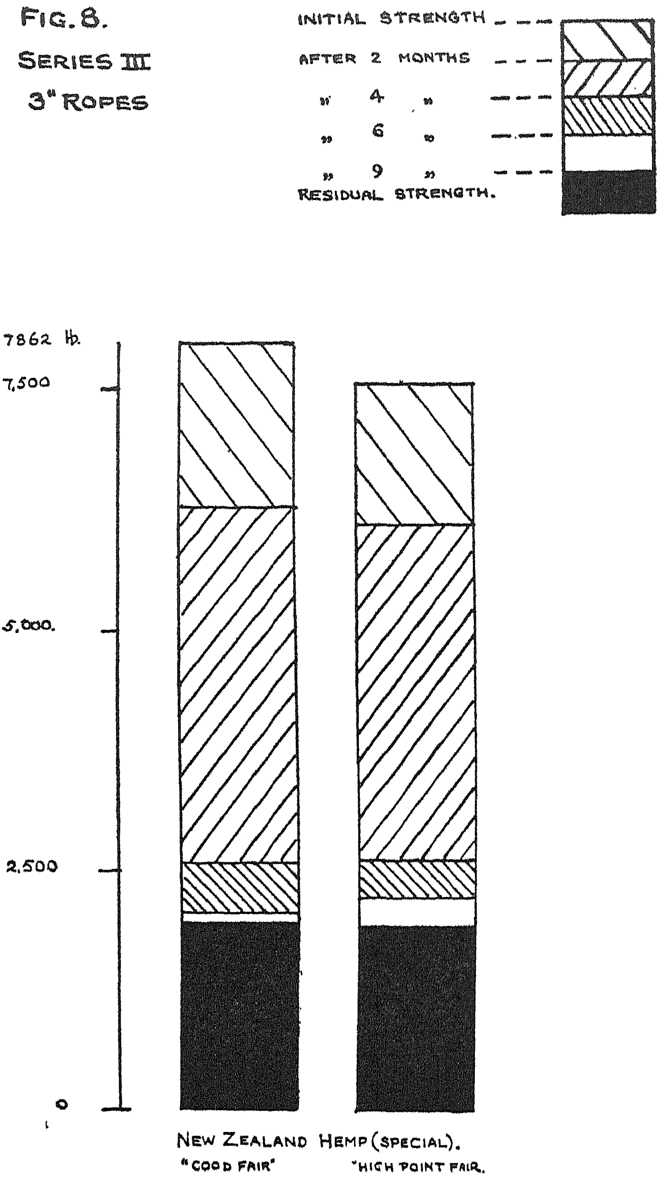

FIG. 8.—Series III. 3-inch ropes.

The ropes were exposed to the action of sea-water by placing them in wooden crates fixed to Southend Pier, in such a position as to ensure that during each tide they were completely submerged for a period and completely uncovered for a period.

The experiments with ropes Nos. 1 to 9 were commenced in July 1929.

The two special New Zealand hemp ropes, Nos. 10 and 11, were not available until later and were not exposed to the action of sea-water until September, i.e. two months after the other experiments had been started. For purposes of control fresh portions of two of the other ropes, No. 1 (Sisal No. 1 Brushed) and No. 9 (New Zealand High Point Fair), were also immersed at the same time ; the quantity of these ropes still available was only sufficient for immersion tests for two and four months, but the results are sufficient to indicate the difference in the rate of decay during the later period.

In order that the ropes might be in the same condition in the tensile tests with regard to humidity, all the test-pieces were thoroughly washed with fresh water and tested in an air-dry condition.

The determination of the breaking strains of the rope was made by means of a Riehlé machine, the method of attachment being made by grips.

The results obtained are given in the following tables and are represented graphically in Figs. 6–8.

Breaking Strain of the Ropes before Immersion

	Sisal.				Manila.	Russian Hemp.	Indian Hemp.	New Zealand Hemp.		New Zealand Hemp (Special).	
	No. 1. No. 1 Brushed.	No. 2. No. 1 Unbrushed.	No. 3. No. 2 Brushed.	No. 4. No. 2 Unbrushed.	No. 5. Streaky 3.	No. 6. Dressed Siretz.	No. 7. Dressed.	No. 8. Fair.	No. 9. High Point Fair.	No. 10. Good Fair.	No. 11. High Point Fair.
	lb.	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
	10,430	11,470	9,220	10,880	9,080	9,270	8,390	7,000	7,890	7,500	7,690
	10,030	10,160	9,680	11,070	9,180	9,210	8,380	7,200	8,540	7,690	7,880
	10,680	11,160	9,000	11,580	9,390	9,190	8,100	7,500	8,090	7,930	7,200
	10,700	11,120	9,660	11,200	9,030	9,240	8,310	7,500	8,000	8,350	7,130
	10,370	10,180	9,370	11,150	9,480	9,890	8,390	7,550	8,110	8,200	7,000
	10,570	11,180	9,390	11,640	9,420	9,110	8,580	7,650	7,990	7,500	7,850
Maximum .	10,700	11,470	9,680	11,640	9,480	9,890	8,580	7,650	8,540	8,350	7,880
Minimum .	10,030	10,160	9,000	10,880	9,030	9,110	8,100	7,000	7,890	7,500	7,000
Variation .	670	1,310	680	760	450	780	480	650	650	850	880
Average .	10,463	10,878	9,387	11,253	9,263	9,318	8,358	7,400	8,103	7,862	7,458

Breaking Strain after 2 Months' Immersion in Sea-water

	Period of Immersion: July 12 to September 12, 1929.									Period of Immersion: September 12 to November 12, 1929.			
	Sisal.				Manila.	Russian Hemp.	Indian Hemp.	New Zealand Hemp.		New Zealand Hemp.			Sisal.
	No. 1. No. 1 Brushed.	No. 2. No. 1 Unbrushed.	No. 3. No. 2 Brushed.	No. 4. No. 2 Unbrushed.	No. 5. Streaky 3.	No. 6. Dressed Siretz.	No. 7. Dressed.	No. 8. Fair.	No. 9. High Point Fair.	No. 10. Good Fair (Special).	No. 11. High Point Fair (Special).	No. 9.[1] High Point Fair.	No. 1.[1] No. 1 Brushed.
	lb.	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
	4,800	5,360	6,180	6,180	7,030	4,670	4,790	4,900	5,850	6,590	5,950	5,830	5,600
	5,640	5,690	5,750	5,800	6,950	5,000	5,330	4,980	6,490	5,810	6,760	5,780	5,650
	5,350	5,080	5,560	7,250	7,060	4,100	5,030	4,850	5,360	6,480	5,550	5,940	5,770
	5,340	5,840	5,830	5,910	7,290	4,960	5,120	4,960	6,000	5,400	6,000	5,210	5,880
	4,970	5,940	6,000	7,190	7,010	4,820	5,040	4,960	5,820	6,650	6,050	5,630	6,280
	5,200	5,600	5,530	6,070	7,130	4,600	4,850	4,960	5,710	6,050	5,810	6,090	6,050
Maximum .	5,640	5,940	6,180	7,250	7,290	5,000	5,330	4,980	6,490	6,650	6,760	6,090	6,280
Minimum .	4,800	5,080	5,530	5,800	6,950	4,100	4,790	4,850	5,360	5,400	5,550	5,210	5,600
Variation .	840	860	650	1,450	340	900	540	130	1,130	1,250	1,210	880	680
Average .	5,217	5,585	5,808	6,400	7,078	4,692	5,027	4,935	5,872	6,163	6,020	5,747	5,872

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[1] *Controls. See page 21.*

Breaking Strain after 4 Months' Immersion in Sea-water

	Period of Immersion: July 12 to November 12, 1929.									Period of Immersion: September 12, 1929, to January 10, 1930.			
	Sisal.				Manila.	Russian Hemp.	Indian Hemp.	New Zealand Hemp.		New Zealand Hemp.			Sisal.
	No. 1. No. 1 Brushed.	No. 2. No. 1 Unbrushed.	No. 3. No. 2 Brushed.	No. 4. No. 2 Unbrushed.	No. 5. Streaky 3.	No. 6. Dressed Siretz.	No. 7. Dressed.	No. 8. Fair.	No. 9. High Point Fair.	No. 10. Good Fair (Special).	No. 11. High Point Fair (Special).	No. 9.[1] High Point Fair.	No. 1.[1] No. 1 Brushed.
	lb.	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
	3,800	3,500	2,670	3,610	4,190	2,520	2,300	2,950	2,810	2,560	2,390	2,460	2,880
	3,560	3,390	2,890	3,610	3,800	2,180	2,310	2,780	2,890	2,450	2,700	2,530	3,010
	3,940	3,070	2,900	3,790	4,340	2,040	2,420	2,970	2,990	2,620	2,480	2,480	2,930
	3,490	2,940	2,650	3,620	4,050	2,040	2,420	2,790	2,550	2,540	2,630	2,470	3,040
	3,520	3,130	2,870	3,440	3,700	1,840	2,570	2,960	2,930	2,500	2,410	2,560	3,100
	3,280	3,130	2,720	3,620	4,230	2,010	2,300	2,860	2,760	2,460	2,660	2,480	3,000
Maximum .	3,940	3,500	2,900	3,790	4,340	2,520	2,570	2,970	2,990	2,620	2,700	2,560	3,100
Minimum .	3,280	2,940	2,650	3,440	3,700	1,840	2,300	2,780	2,550	2,450	2,390	2,460	2,880
Variation .	660	560	250	350	640	680	270	190	440	170	310	100	220
Average .	3,598	3,193	2,783	3,615	4,052	2,105	2,387	2,885	2,822	2,522	2,545	2,497	2,993

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[1] *Controls. See page 21.*

Breaking Strain after 6 Months' Immersion in Sea-water

	Period of Immersion: July 12, 1929, to January 10, 1930.									Period of Immersion: September 12, 1929, to March 14, 1930.	
	Sisal.				Manila.	Russian Hemp.	Indian Hemp.	New Zealand Hemp.		New Zealand Hemp.	
	No. 1. No. 1 Bushed.	No. 2. No. 1 Unbrushed.	No. 3. No. 2 Brushed.	No. 4. No. 2 Unbrushed.	No. 5. Streaky 3.	No. 6. Dressed Siretz.	No. 7. Dressed.	No. 8. Fair.	No. 9. High Point Fair.	No. 10. Good Fair (Special).	No. 11. High Point Fair (Special).
	lb.	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
	3,100	3,020	2,010	3,320	3,060	1,290	1,520	2,260	2,330	1,980	2,200
	3,000	3,000	2,180	2,990	3,150	1,390	1,830	2,250	2,210	2,000	2,020
	2,980	2,970	1,760	2,830	2,900	1,490	1,810	2,040	2,340	2,050	2,190
	2,020	3,010	2,130	3,310	2,880	1,230	1,560	2,330	2,160	1,940	2,070
	2,910	2,970	1,620	3,290	2,730	1,320	1,420	2,280	2,130	1,870	2,170
	2,400	3,230	1,780	3,170	2,730	1,500	1,420	2,520	2,080	1,980	2,400
Maximum .	3,100	3,230	2,180	3,320	3,150	1,500	1,830	2,520	2,340	2,050	2,400
Minimum .	2,020	2,970	1,620	2,830	2,730	1,230	1,420	2,040	2,080	1,870	2,020
Variation .	1,080	260	560	490	420	270	410	480	260	180	380
Average .	2,735	3,033	1,913	3,152	2,908	1,370	1,593	2,280	2,208	1,970	2,175

Breaking Strain after 9 Months' Immersion in Sea-water

	Period of Immersion: July 12, 1929, to April 11, 1930.									Period of Immersion: September 12, 1929, to June 12, 1930.	
	Sisal.				Manila.	Russian Hemp.	Indian Hemp.	New Zealand Hemp.		New Zealand Hemp.	
	No. 1. No. 1 Brushed.	No. 2. No. 1 Unbrushed.	No. 3. No. 2 Brushed.	No. 4. No. 2 Unbrushed.	No. 5. Streaky 3.	No. 6. Dressed Siretz.	No. 7. Dressed.	No. 8. Fair.	No. 9. High Point Fair.	No. 10. Good Fair (Special).	No. 11. High Point Fair (Special).
	lb.	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
	2,780	2,010	1,400	2,090	2,560	1,150	1,650	2,200	2,140	1,760	1,840
	2,880	2,430	1,700	1,800	2,510	1,290	1,180	2,320	1,880	2,060	1,770
	2,690	2,200	2,400	1,500	3,020	980	1,280	2,390	1,900	1,680	1,840
	2,430	1,880	2,120	3,000	2,690	960	1,320	2,050	2,060	1,960	2,000
	2,610	1,860	2,130	2,120	2,820	1,090	1,660	2,230	1,930	2,070	1,980
	2,500	2,430	2,160	2,320	3,070	880	1,630	2,320	1,990	1,850	1,870
Maximum .	2,880	2,430	2,400	3,000	3,070	1,290	1,660	2,390	2,140	2,070	2,000
Minimum .	2,430	1,860	1,400	1,500	2,510	880	1,180	2,050	1,880	1,680	1,770
Variation .	450	570	1,000	1,500	560	410	480	340	260	390	230
Average .	2,648	2,135	1,985	2,138	2,778	1,058	1,453	2,252	1,983	1,897	1,883

SUMMARY

In the following tables are given the average strength (in pounds) of each rope before immersion, the average strength after each period of immersion, and the loss of strength expressed as a percentage of the original average strength of the rope.

	Sisal.				Manila.
	No. 1. No. 1 Brushed.	No. 2. No 1 Unbrushed.	No. 3. No. 2 Brushed.	No. 4. No. 2 Unbrushed.	No. 5. Streaky 3.
	lb.	*lb.*	*lb.*	*lb.*	*lb.*
Original Average Strength	10,463	10,878	9,387	11,253	9,263
Period of Immersion 2 months (July 12–September 12)					
Average Strength. .	5,217	5,585	5,808	6,400	7,078
Percentage Loss . .	50·1	48·6	38·1	43·1	23·6
Period of Immersion 4 months (July 12–November 12)					
Average Strength. .	3,598	3,193	2,783	3,615	4,052
Percentage Loss . .	65·6	70·6	70·4	67·9	56·3
Period of Immersion 6 months (July 12–January 10)					
Average Strength. .	2,735	3,033	1,913	3,152	2,908
Percentage Loss . .	73·9	72·1	79·6	71·9	68·6
Period of Immersion 9 months (July 12–April 11)					
Average Strength. .	2,648	2,135	1,985	2,138	2,778
Percentage Loss . .	74·7	80·4	78·9	81·0	70·0

	Russian Hemp.	Indian Hemp.	New Zealand Hemp.	
	No. 6. Dressed Siretz.	No. 7. Dressed.	No. 8. Fair.	No. 9. High Point Fair.
	lb.	*lb.*	*lb.*	*lb.*
Original Average Strength .	9,318	8,358	7,400	8,103
Period of Immersion 2 months (July 12–September 12)				
Average Strength . .	4,692	5,027	4,935	5,872
Percentage Loss . .	49·6	39·8	33·3	27·5
Period of Immersion 4 months (July 12–November 12)				
Average Strength . .	2,105	2,387	2,885	2,822
Percentage Loss . .	77·4	72·6	61·0	65·2
Period of Immersion 6 months (July 12–January 10)				
Average Strength . .	1,370	1,593	2,280	2,208
Percentage Loss . .	85·3	80·9	69·2	72·8
Period of Immersion 9 months (July 12–April 11)				
Average Strength . .	1,058	1,453	2,252	1,983
Percentage Loss . .	88·6	82·6	69·6	75·5

	New Zealand Hemp (Special).		New Zealand Hemp.	Sisal.
	No. 10. Good Fair.	No. 11. High Point Fair.	No. 9.[1] High Point Fair.	No. 1.[1] No. 1 Brushed.
	lb.	*lb.*	*lb.*	*lb.*
Original Average Strength .	7,862	7,458	8,103	10,463
Period of Immersion 2 months (September 12–November 12)				
Average Strength . .	6,163	6,020	5,747	5,872
Percentage Loss . .	21·6	19·3	29·1	43·9
Period of Immersion 4 months (September 12–January 10)				
Average Strength . .	2,522	2,545	2,497	2,993
Percentage Loss . .	67·9	65·9	69·2	71·4
Period of Immersion 6 months (September 12–March 14)				
Average Strength . .	1,970	2,175	—	—
Percentage Loss . .	74·9	70·8	—	—
Period of Immersion 9 months (September 12–June 11)				
Average Strength . .	1,897	1,883	—	—
Percentage Loss . .	75·8	74·7	—	—

[1] *Controls. See page 21.*

In the following table the percentage decreases in average strength shown by each rope are collected together for convenience of comparison.

	Sisal.				Manila.
	No. 1. No. 1 Brushed.	No. 2. No. 1 Unbrushed.	No. 3. No. 2 Brushed.	No. 4. No. 2 Unbrushed.	No. 5. Streaky 3.
Months	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
2 (July 12–September 12).	50·1	48·6	38·1	43·1	23·6
4 (July 12–November 12).	65·6	70·6	70·4	67·9	56·3
6 (July 12–January 10) .	73·9	72·1	79·6	71·9	68·6
9 (July 12–April 11) .	74·7	80·4	78·9	81·0	70·0

	Russian Hemp.	Indian Hemp.	New Zealand Hemp.	
	No. 6. Dressed Siretz.	No. 7. Dressed.	No. 8. Fair.	No. 9. High Point Fair.
Months	*lb.*	*lb.*	*lb.*	*lb.*
2 (July 12–September 12) .	49·6	39·8	33·3	27·5
4 (July 12–November 12) .	77·4	72·6	61·0	65·2
6 (July 12–January 10) . .	85·3	80·9	69·2	72·8
9 (July 12–April 11) . .	88·6	82·6	69·6	75·5

	New Zealand Hemp (Special).		New Zealand Hemp.	Sisal.
	No. 10. Good Fair.	No. 11. High Point Fair.	No. 9.[1] High Point Fair.	No. 1.[1] No. 1 Brushed.
Months	*lb.*	*lb.*	*lb.*	*lb.*
2 (September 12–November 12)	21·6	19·3	29·1	43·9
4 (September 12–January 10) .	67·9	65·9	69·2	71·4
6 (September 12–March 14) .	74·9	70·8	—	—
9 (September 12–June 11) .	75·8	74·7	—	—

[1] *Controls. See page 21.*

CONCLUSIONS ON SERIES III

Sisal and Manila.—It will be observed that the four Sisal ropes had greater initial strength than the Manila ropes, those made from the Unbrushed No. 1 and No. 2 being the strongest. After two months' exposure to sea-water, the Sisal ropes had undergone a reduction of strength considerably greater than that of the Manila rope and also greater than that suffered by the Sisal ropes in Series I and Series II of the trials. Subsequently the rate of deterioration decreased, the average percentage loss being only 23·7 in the third and fourth months as compared with 44·9 in the first two months; in contrast with this the Manila rope, which lost only 23·6 per cent. of its strength in the first two months, lost 32·7 per cent. in the following two months. In the fifth and sixth months of the trial the rate of deterioration of the Sisal ropes again diminished, as did also that of the Manila rope. At this period of the trial (that is, after six months' exposure to sea-water), three of the Sisal ropes were approximately equal in actual breaking load to the Manila rope, although the percentage loss of strength of the former was slightly greater. At the conclusion of the test, after nine months' exposure, the No. 1 Brushed Sisal rope was practically equal in strength to the Manila rope, whilst the three other Sisal ropes were slightly inferior. With respect to percentage loss of strength, the Manila hemp had suffered the least, whilst the loss in the case of the No. 1 Brushed Sisal rope was but slightly greater.

The results of this series of trials show that the resistance of the No. 1 Brushed Sisal rope to sea-water was slightly, but not materially, inferior to that of the Manila Streaky No. 3 rope used for comparison, whilst the three other grades of Sisal were a little more inferior in this respect to the Manila rope.

New Zealand (*Phormium*) *Hemp.*—The four New Zealand hemp ropes used in the trials were all of lower initial strength than the Manila Streaky No. 3 rope and the four Sisal ropes. During the first two months of exposure to sea-water they suffered a smaller loss than the Sisal ropes and more resembled the Manila rope in behaviour. During the third and fourth months, however, the Phormium ropes sustained a large loss, so that at the end of four months' exposure the percentage loss undergone by the Phormium ropes was nearly equal to that of the Sisal ropes, and slightly greater than that of the Manila rope.

Considering the results over the whole period of duration of the trials, the resistance of the four Phormium ropes to deterioration by sea-water proved equal to those of the No. 1 Brushed Sisal rope and the Manila Streaky No. 3 rope. As, however, the initial strength of the Phormium ropes was less than that of the two last-mentioned ropes, the final strength was also lower, and was approximately equal to that of the other three grades of Sisal. The four grades of New Zealand hemp showed very little difference in their respective behaviour towards sea-water. The Fair Grade was slightly, but not materially, superior to the other three grades, which behaved in almost exactly the same way to one another.

Russian and Indian (Sunn) Hemps.—In these tests the Indian (Sunn) hemp rope showed throughout a greater resistance to sea-water than the Russian hemp rope. Both ropes, however, proved distinctly inferior in this respect to the Manila, Sisal and Phormium ropes.

In issuing this report the Imperial Institute Advisory Committee on Vegetable Fibres wish to express their grateful appreciation of the valuable assistance rendered by the Pier Committee of the Corporation of Southend-on-Sea in kindly providing the necessary facilities for the immersion of the ropes.

Appendix

Rope Tests by the Admiralty

SISAL

CONCURRENTLY with the tests carried out by the Imperial Institute and described in the foregoing report, the Admiralty also conducted a series of independent trials on similar lines. The ropes used in these trials were manufactured by the Admiralty from (*a*) Manila J grade and (*b*) British East African Brushed Sisal, First Quality, and were exposed to the action of sea-water at Sheerness and Devonport.

The results of these exposure tests, which were carried out under similar conditions to those employed in the Imperial Institute tests, were reported by the Admiralty as follows:

"*Sea Exposure Tests.*—Over a six months' exposure period, the Sisal compared very closely with the Manila. In the final stages of the 12 months' trials the Manila gave the best results. Generally, however, the Sisal fibre can be regarded as satisfactory so far as its capacity to resist the action of sea-water is concerned."

A further series of exposure tests was also planned with a view to imitating service conditions more closely. In this series a portion of each of the ropes was removed from the sea at Devonport at the end of six months' sea exposure and was wound closely round drums in a wet condition. Some of the drums were then exposed to weather conditions and others retained under cover in the Ropery. The report on these tests was as follows:

"*Exposure on drums after removal from sea-water.*—The Sisal withstood the conditions of this test over the five months' period of exposure equally as well as the Manila."

The results of these tests are summarised by the Admiralty as follows:

"*British East African Brushed Sisal—No. 1 Quality.*

"(*a*) Much better appearance than Manila owing to the light colour of the fibre.

"(*b*) Higher initial breaking strain than Manila.

"(*c*) Capable of withstanding the action of sea-water over a prolonged period.

"(*d*) Compares favourably with Manila when exposed under service conditions.

"(*e*) When immersed in sea-water, Sisal compared with Manila:

> "(i) Absorbs water at a much quicker rate and sinks more rapidly.
>
> "(ii) Swells more.
>
> "(iii) Shrinks in length at a quicker rate.
>
> "(iv) Does not return to its original size when dry, but remains in its expanded state, whereas Manila gradually returns to its approximate original size."

Subsequent to the conclusion of the exposure tests, the balance of the Sisal cordage was issued to certain of H.M. ships for small-scale trial under service conditions. This cordage was used for boats' falls, and during the trial period it was subject to exceptionally wet weather. The falls satisfactorily completed the normal period of service.

In view of the satisfactory results it has been decided to carry out further trials of cordage made from No. 1 brushed Sisal. It will be used as boats' falls, etc., and steps are being taken to note how it compares with Manila as regards flexibility and ease of handling, and whether any difficulties arise from swelling or mildew.

New Zealand Hemp

The Admiralty has also carried out trials with New Zealand hemp, the ropes used for the purpose being made from three grades of the fibre, viz. " B " Fine, Good Fair and High Point Fair.

The initial strengths of these ropes were distinctly higher than those of the four ropes made from New Zealand hemp which were tested at the Imperial Institute, but did not quite attain the standard demanded by Government Departments for 3-inch Manila ropes. In the sea-exposure tests the New Zealand grades are stated to " compare closely with Sisal, but are not up to the standard of Manila. Each grade, so far as their capacity to resist the action of sea-water is concerned, can be regarded as fairly satisfactory."

The results of the trials are summarised as follows :

1. The best of the New Zealand grades is High Point Fair, and further trials are now proceeding in the Naval Service.

2. The " B " grade and Good Fair cannot be regarded as suitable for the manufacture of Admiralty cordage, in view of their low initial tensile strength.

3. Fibre somewhat same colour as Manila, but rather coarser.

4. All grades capable of withstanding the action of sea-water over prolonged periods, although hardly up to the standard of Manila.

5. When immersed in sea-water all the New Zealand grades :

(*a*) Absorb water at a much greater rate than Manila and sink more rapidly, but are rather better in this respect than Sisal.

(*b*) Swell more and remain swollen when subsequently dried.

GINGER FROM NIGERIA

ALTHOUGH ginger is produced for local consumption throughout British West Africa, the only country in that region which has hitherto grown the crop for export is Sierra Leone. Attempts are, however, being made in Nigeria by the Department of Agriculture to establish an export industry in the Southern Zaria district of the Northern Provinces. The Annual Report of the Department for 1929 points out that the importance of the extension work now being successfully carried out in that region lies in the fact that although this area is traversed by the Eastern Railway no exportable crop whatever has yet been produced there. In 1928, about 6 tons of prepared ginger were exported and were sold in England at 65*s*. per cwt. In 1929, 11½ tons were purchased ; part of this was sold through the Imperial Institute and the report on the consignment furnished to the Government of Nigeria is included in the following article. Although the Department considers it unlikely that the industry will ever be a large one, owing to the labour required to prepare the ginger in a form suitable for the export trade, it is eminently suited to this particular district, where, from time immemorial, ginger has been grown to supply the very considerable requirements of the ten million people of the Northern Provinces who use the product for medicinal and veterinary purposes.

The Department is at present concentrating on improving the quality of the ginger. Each lot of ginger, before being purchased, is carefully graded, whilst experiments are being conducted to ascertain whether the quality can be improved by selection or by the introduction of a better variety. In addition to this the effects of manuring and better cultivation are also being studied.

Four samples, representing different grades of ginger prepared in Southern Zaria, were forwarded by the Department of Agriculture to the Imperial Institute in September 1930 and the results of their examination are given below.

Some attention is also being devoted to the production of ginger for export in the Southern Provinces of Nigeria, and a small consignment was received for sale through the Imperial Institute in 1929. The report on this consignment is also given in the following pages.

I. CONSIGNMENT FROM THE NORTHERN PROVINCES

This consignment was stated to comprise 530 lb. of first-grade ginger and 8,164 lb. of second-grade ginger purchased by officers in Zaria, the prices paid locally for the two grades being £40 and £30 per ton respectively. The consignment consisted of the following lots, reference samples of which were examined at the Imperial Institute :

Grade I (530 *lb.*), *marked NA*-1.—Peeled ginger, fairly bold and clean, but rather dark-coloured on the surface. The ginger was fairly soft on cutting.

Grade II (200 *lb.*), *marked NA*-2 (*Special*).

Grade II (7,964 *lb.*), *marked NA*-2 (*Ordinary*).

Both these lots consisted of peeled ginger which was fairly bold, but less so than the sample of Grade I. The ginger was clean, but externally was of a still darker tint than Grade I ; and on the whole was not so soft on cutting.

The consignment was placed in the hands of a firm in London, who reported that all the lots represented ginger of the same character as that obtained from Jamaica, but stated that although the ginger cut fairly well it was darker externally than the Jamaica product and, as it would be used mainly for grinding, would not realise such a high price as even the lowest quality from that Colony. They also reported that buyers on the London market were fairly well supplied with stocks of ginger at that time and that offers for the consignment were therefore not readily obtainable, and in the circumstances they expressed their willingness to take over the entire consignment themselves at 65*s*. per cwt. At the same date (August 1929) Jamaica ginger was selling in the market at 72*s*. 6*d*. to 100*s*. per cwt. according to quality, whilst West African types were being held for 63*s*. per cwt.

The firm stated that if valued separately the first-grade ginger in the consignment would be worth possibly about 2*s*. 6*d*. per cwt. more than the second-grade material, but that there was practically no difference in quality between the " special " and " ordinary " lots of the second grade.

In view of all the circumstances the Imperial Institute agreed to the sale of the consignment to the firm at the price mentioned.

It was pointed out to the Nigerian Government that although the results of the sale of this small consignment were promising, they indicated that an effort should be made to produce ginger of a paler colour externally, as the value of the product would thereby be enhanced. The exact price obtainable for commercial quantities would depend on the state of the market at the time, but if the quality of future shipments did not fall below that of the present consignment there should be no difficulty in disposing of them.

II. GRADES OF GINGER FROM THE NORTHERN PROVINCES

Four samples representing different grades of ginger prepared by native growers in Southern Zaria were forwarded in September 1930 in order to ascertain the value of the grades and the suitability of the grading. The grades adopted were as follows :

Special Grade.—White plump hands.

Grade I.—Any other white ginger.

Grade II.—Slightly discoloured ginger in good condition.

Grade III.—Any other ginger fit for export.

The description and results of examination of the samples are given below.

Special Grade.—This sample consisted of unbleached ginger in good, clean condition. The hands were bold, plump, and pale brownish-cream externally. They had a very good appearance and had been well scraped. The length varied from 1½ to 4 in. The ginger was fairly soft, the fracture short but slightly fibrous, and the pungency good.

Grade I.—This sample consisted of hands up to 3 in. in length, together with small pieces. The ginger was much less bold and the fracture rather more fibrous than in the case of the Special Grade, but in other respects the two samples were similar.

Grade II.—This ginger was very similar to Grade I, but was not so well scraped and the colour externally was slightly browner. It consisted of small pieces and hands up to 3½ in. in length. The fracture was slightly more fibrous and the ginger was a little harder than Grade I.

Grade III.—Small pieces of ginger and hands up to 3 in. in length. The product was not so well scraped as Grade II and was inferior to the latter in colour.

The samples were submitted to a firm of merchants in London, who furnished the following report (November 1930):

Special Grade.—This represents a very distinct improvement on any ginger hitherto produced in Nigeria. It is bold, and soft when cut. Commercial supplies would meet with a considerable demand. It corresponds to Good Bold Jamaica, and would be worth 95*s*. per cwt. in London.

Grade I.—This ginger should realise 55*s*. per cwt. in London.

Grade II.—This ginger corresponds to Jamaica No. 3 and would be worth 45*s*. to 50*s*. per cwt. in London.

Grade III.—This sample is equal to the usual quality of ginger shipped from Nigeria, and should realise about 45*s*. per cwt. in London.

Of these samples the " Special Grade " and " Grade I " are markedly superior to the gingers previously received at the Imperial Institute from Nigeria. Consignments of any of the four qualities would be readily saleable in London, and the Imperial Institute has informed the Nigerian authorities that it will be glad to assist, if so desired, in the marketing of trial shipments.

III. Consignment from the Southern Provinces

This consignment, received in July 1929, consisted of about 2½ cwts. of peeled ginger, prepared by native farmers in the Ilesha district of the Oyo Province, from whom it had been purchased at £35 per ton.

The material consisted of peeled unbleached ginger, in the form of hands 1½ to 4 in. long and in good, clean condition. The hands, which were mostly well peeled, were plump and fairly bold, but brownish externally. The ginger was on the whole of satisfactory quality but not quite so good as the Grade I of the consignment from the Northern Provinces (see pp. 36 and 37).

The consignment was placed in the hands of a firm of merchants in London, who reported on it as follows :

> " The quality is a distinct advance on what we have seen previously, and the texture of the ginger is soft. The inside is of good colour and it is not quite so fibrous as common Jamaica, but in comparing the two we notice that the African ginger is a little darker in the outside appearance, and would, therefore, not be quite so acceptable for selling whole. We do not, of course, know the process pursued in cleaning the ginger, but it is possible that the appearance in question may be improved, and in that case it would probably realise as much as Jamaica."

The firm purchased the consignment at 67*s*. 6*d*. per cwt., with common Jamaica ginger at 70*s*. per cwt.

GERANIUM OIL FROM SOUTH AFRICA

A sample of geranium oil was forwarded to the Imperial Institute by the Director, National Botanic Gardens, Kirstenbosch, in October 1930, with a view to ascertaining its quality and market value.

The oil was stated to have been obtained from a variety of Pelargonium in cultivation in the Gardens and originally obtained from France. The material was harvested when in full flower and distilled in the fresh condition, the yield of oil being 0·148 per cent.

The sample consisted of a pale greenish-yellow oil with the characteristic odour of geranium oil.

It was examined with the following results, which are shown in comparison with those recorded for commercial Algerian and Bourbon geranium oils :

—	Present sample.	Commercial geranium oils.	
		Algerian.	Bourbon.
Specific gravity at 15/15° C.	0·9021	0·892–0·904	0·888–0·896
Optical rotation α_D . .	−12·51°	−6·5° to −12°	−7·8° to −13·8°
Refractive index n_D 20° C..	1·4723	1·465–1·472	1·462–1·468
Acid value . . .	3·3	1·5–9·5	1·5–12
Ester value . . .	72·0	34–70	50–78
Esters (expressed as geranyl tiglate) . *per cent.*	30·3	14·3–29·5	21–33
Ester value after acetylation	216·2	203–230	206–233
Equivalent to :— Total alcohols (expressed as geraniol) *per cent.*	71	62–71·5	60–71
Solubility in 70 per cent. alcohol at 15° C.	Soluble with slight opalescence in 2·5 vols.	Soluble in 2 to 3 vols.	Soluble in 2 to 3 vols.

The results show that the oil contains a normal amount of esters, and that its constants fall within the range for commercial geranium oils.

The oil was submitted to a firm of distillers in London, who furnished the following observations regarding its quality and value :

" So far as the constants are concerned the oil approximates very closely to the Algerian type. The odour, however, is somewhat different, and is reminiscent of palmarosa oil. It is an oil for which we could find a use providing the price was slightly below the cost to us of Bourbon or Algerian oil, whichever could be bought more cheaply. Now the price of Bourbon oil is 12*s.* 6*d.* per lb. c.i.f. London, and Algerian is nominally 15*s.* per lb." (December 1930).

In view of the fact that the sample represented a geranium oil of good quality which would be readily saleable in the United Kingdom, it was suggested that if it were found possible to produce the oil on a sufficient scale a trial shipment should be sent to the Imperial Institute for sale.

MUTTON-BIRD OIL AND FAT FROM AUSTRALIA

In 1926, samples of mutton-bird oil and fat were forwarded by the Chief Chemist to the Tasmanian Government for examination at the Imperial Institute, and in October 1930 a further sample of the oil was received from the Office of the High Commissioner for Australia. The results of examination of these samples are given below.

Mutton-Bird Oil

No. 1.—Received in 1926. This sample was labelled "Oil from the short-tailed Petrel." It consisted of a clear, limpid oil, of reddish-orange colour and having an odour resembling that of cod-liver oil. On standing the oil deposited a very small quantity of stearine.

No. 2.—Received in 1930. This sample consisted of a reddish-brown, clear, liquid oil, with an odour resembling that of cod-liver oil.

The two samples of oil were examined with the following results, which are shown in comparison with the figures recorded for mutton-bird oil by other investigators :

—	No. 1.	No. 2.	Range of figures previously recorded.
Specific gravity at 15/15° C.	0·8880	0·8882	0·8819–0·8858
Refractive index at 40° C.	1·466	1·465	1·4636
Acid value	4·0	4·5	4·5–5·7
Saponification value	125·0	120·5	119·6–125·9
Iodine value (Wijs, 3 hrs.) *per cent.*	131·6[1]	138·8	71·0–132·0
Unsaponifiable matter *per cent.*	36·5	41·7	31·1–38·4
Solidifying point of fatty acids	below 18° C.	below 15° C.	—

[1] Hübl, 17 hrs.

These results show that the oils were of normal character, although the amount of unsaponifiable matter in Sample No. 2 was rather higher than had been previously recorded.

Mutton-bird oil resembles sperm oil in its chemical characters, and might be used as a substitute for it for lubricating and other purposes. It seems hardly likely, however, that the oil could be produced sufficiently cheaply to enable it to compete in the market with sperm oil, which is quoted in the United Kingdom at the following prices: No. 1, crude, £20 per ton; filtered, £25 per ton (February 6, 1931).

It is possible that the oil might have a use in medicine for similar purposes to cod-liver oil, as it has been stated to contain vitamins A and D, and to be digestible, although it is of a wax-like nature.

Mutton-Bird Fat

The sample received from Tasmania in 1926 consisted of dark brown, very soft fat containing a small amount of mechanical impurity. It had a strong odour which somewhat resembled that of cod-liver oil.

The fat was examined with the following results, which are shown in comparison with those previously recorded for this product:

	Sample from Tasmania.	Range of figures previously recorded.
Specific gravity . . .	0·8652 at 100/15° C.	0·9351–0·9380 at 15/15° C.
Acid value . . .	5·8	6·8–8·6
Saponification value . .	189·7	200·0
Iodine value, Hübl, 17 hrs. *per cent.*	106·5	99·5
Unsaponifiable matter *per cent.*	1·6	0·98–2·0
Refractive index at 40° C. .	1·466	1·4637
Solidifying point of fatty acids	28·4° C.	29·4° C.

It will be seen that the results given by this sample agree fairly closely with the figures previously recorded.

Mutton-bird fat is different in nature from the oil and appears to possess the ordinary characters of animal fats. Its chief outlet would probably be in the manufacture of soap.

ARTICLE

EMPIRE TIMBERS FOR DECORATIVE AND BUILDING WORK

From time to time during recent years the Imperial Institute has furnished information to architects and others in regard to timbers derived from overseas countries of the Empire which can be recommended for decorative or constructional purposes in public and other buildings and in private houses. The interest in such timbers for use either as alternatives to the standard woods (mostly foreign) hitherto employed almost invariably for these purposes, or as materials affording a welcome change in appearance and character from the established woods, is steadily increasing, and it has been considered that an account of some of the suggestions made in this connection by the Imperial Institute might usefully be published. Acknowledgments are due to Major Ralph J. Holliday, M.C., Mr. E. Locks Latham and Mr. H. Stainton Tireman (Timber Adviser to the High Commissioner for India), members of the Imperial Institute Advisory Committee on Timbers, and to Mr. E. Bryan Latham and Messrs. Wm. Mallinson and Sons, Ltd., for further particulars kindly supplied by them.

A few preliminary remarks on the rise of Empire timbers in commercial and public favour may not be out of place. Architects and builders are commonly regarded as showing a strong conservatism when considering proposals for the use of timbers to which they are not accustomed, and a similar reluctance to engage in business in new woods has hitherto been attributed to the timber trade. So far as this attitude is correctly ascribed to the interests mentioned, it must be recognised as being founded on the most rational basis. Timber merchants cannot be expected to take unlimited risk in introducing new timbers which they are aware will be avoided by their average customers because the woods are novelties; while architects, regarding the interests of their clients and their own reputation as matters of primary concern, have declined to risk the use of timbers of whose behaviour in practice they have no experience, and regarding which it has been difficult to obtain reliable information.

Strong effort has been made during the past fifteen years to free the interested parties from this deadlock. The Imperial Institute Advisory Committee on Timbers, established in 1916, has this object in view, and other outstanding factors which have contributed to the present changed position of affairs are the action taken by the Government of India, with the co-operation of Messrs.

W. W. Howard Bros. & Co., to market selected Indian woods ; the publication of the report on Indian Timbers by the Imperial Institute Indian Trade Enquiry (1921) ; the Empire Timber Exhibition (1920), organised by the Department of Overseas Trade, which was remarkable for the display of Indian decorative woods ; and the timber sections at the British Empire Exhibition at Wembley (1924–25). More recently, the Empire Timber Exhibition at the Imperial Institute (1928), which coincided with the publication of the " Descriptive List of Some Empire Timbers recommended by the Imperial Institute Advisory Committee on Timbers "[1] ; the Report on Timber by the Imperial Economic Committee (1928)[2] ; and exhibitions of Australian woods organised by the High Commissioner at Australia House, as well as displays of Empire timbers at trade exhibitions, have played their part in the movement. As the outcome of the report by the Imperial Economic Committee above mentioned, the Forest Products Research Laboratory at Princes Risborough is now devoting special attention to the development of the use of Empire woods. For the most part this official work would have been impossible and fruitless but for the co-operation and initiative of the timber trade. The results achieved to date afford a good example of what can be accomplished by a combination of official and commercial effort ; while a number of enterprising architects and builders have given the final and essential impetus to the movement by the pioneer use of selected woods recommended to them. It is satisfactory to state that, to date, no failures of any material importance appear to have been reported.

The experience which has now been gained regarding a useful selection of Empire woods enables satisfactory replies to be given to the questions necessarily asked by prospective users. The timbers are establishing themselves on their merits. The decorative woods offer a wide range of choice in attractive and even handsome appearance. Practically all the timbers now coming into use are satisfactory in working qualities when once any special characters are understood by the workmen (in which respect the new woods differ in no way from the woods in standard use); in this connection it may be mentioned that a good range of Empire timbers is now used as routine material by the staff mechanics at the Imperial Institute for constructional and decorative work. Supplies and prices are reasonable although, in general, the choicer decorative woods are not cheap and find their natural and best outlet in good or high-class work, a statement which is not intended to suggest that the use of the woods is feasible only for expensive undertakings. It is no detriment to Empire timbers to urge the importance of careful selection, and insistence on guaranteed completeness of seasoning when purchasing supplies. For all high-class work such precautions are taken as ordinary procedure in regard to foreign timbers, and Empire woods require similar consideration if justice is to be done to them. There is, however, no difficulty in obtaining satisfactory material from reliable timber merchants. Prospective users desire to inspect examples of the employment of the timbers in practice. Samples of the woods and some instances of their use may be seen at the Imperial Institute, and certain timber merchants now maintain show-rooms displaying the use of the woods for panelling, joinery and flooring. Special attention, however, is drawn to the register of notable examples of the use of Empire woods for construction and decorative purposes in public and other buildings which is maintained by the Empire Marketing Board. The register is available for consultation on application to the Secretary of the Board. A few notable examples of such use are mentioned below.

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[1] Obtainable from the Imperial Institute, London, S.W.7, price 2*s*.

[2] Cmd. 3175. Obtainable from H.M. Stationery Office, price 9*d*.

Reference may here be made to the fact that, at the instance of the Imperial Institute Timbers Committee, application was made to the London County Council for a small number of Empire timbers selected by the Committee to be submitted to the official tests of the Council with a view to their inclusion in the list of timbers mentioned in the Schedule of the London Building Acts (Amendment) Act, 1905, as fire-resisting materials. The following woods have been accepted by the Council as fire-resisting: Andaman Padauk; Crabwood and Mora from British Guiana; African walnut and Iroko (African teak). An additional number of very useful timbers has thus become available for essential structures of buildings. (See also p. 73.)

The following pages contain suggestions as to timbers of Empire origin which can be employed with satisfactory results in the construction of public and commercial buildings and private houses. The principal uses for which timbers are suggested are panelling, staircases, joinery, flooring and carcassing. The woods are not described in detail. Characteristic features are usually given and fuller particulars will be found in the "Descriptive List of Some Empire Timbers recommended by the Imperial Institute Advisory Committee on Timbers (1928)." A further publication dealing with Empire woods is to be issued by the Empire Marketing Board. No reference is made below to English home-grown timbers, such as oak, brown oak, walnut, ash or elm, whose qualities have universal recognition in this country.

Timbers for Panelling

A useful number of Empire woods form admirable materials for panelling. Selected timbers are highly decorative and sufficient experience has now been gained with them to show that they stand well and are entirely satisfactory for the purpose. It is strongly recommended that the timbers be used as veneer upon an approved backing, preferably a plywood or laminated backing.

Mahoganies

Mahoganies of Empire origin are among the finest in commerce, and now form a large proportion of the mahoganies used in industry. Practically all the grades of foreign mahoganies, with the exception of the Cuban and San Domingan sorts, can be matched as regards general characters and working qualities, and there is no reason why the Empire woods should not be used for most purposes where mahogany is desired. The woods have an excellent appearance, and figured material, over a wide range of development, is readily obtainable. The woods have most satisfactory working qualities and take colour and polish to perfection. The principal varieties are HONDURAS MAHOGANY (*Swietenia macrophylla* King) from British Honduras, which needs no more than mention; and the African mahoganies marketed as BENIN, LAGOS, CHERRY and SAPELE mahoganies (from Nigeria), together with the AXIM, SECCONDEE (Secondi) and ACCRA sorts from the Gold Coast. Sapele mahogany is derived from trees of the genus Entandrophragma; the remaining African mahoganies mentioned are obtained from species of Khaya. Both these genera belong to the true mahogany family (Meliaceæ). When African mahogany is required it is most desirable to order it under the names quoted (Benin, Lagos, etc.) and not as "African mahogany." Sapele mahogany is well known for the characteristic "stripe" when the timber is quarter-sawn. Only quarter-sawn stock of this mahogany should be used and it is best employed as a veneer. The extent to which the "stripe" can be used in panelling is a matter for personal decision.

Indian Timbers

A measure of the decorative and practical value of the fine series of Indian woods introduced in recent years is afforded by the importance of the buildings in which they have been freely used for panelling and other purposes. The most notable instance of such use is India House, Aldwych, and special mention may also be made of the Bank of England in Finsbury Circus, and the offices of Imperial Chemical Industries Ltd. At India House, extensive panelling, which is probably unrivalled as concerning the respective timbers, has been carried out in Laurelwood, Burma Padauk, Silver Greywood, White Bombway and Kokko. All the timber used is in veneer mounted on a backing of Moulmein cedar (*Cedrela Toona* Roxb.), a wood of proved merit for this purpose. Fine workmanship has enhanced the beauty of all the timbers used, but special reference may be made to the results obtained with figured Burma Padauk, Laurelwood and Kokko. Notes on the woods used will be found below.

A small but instructive example of the use of Indian woods for utility and decorative purposes is afforded by the new series of cases for panoramas shown in the Indian Section of the Public Exhibition Galleries of the Imperial Institute, where Gurjun, White Chuglam, Teak, Silver Greywood, Andaman Padauk, Indian White Mahogany and Kokko have been successfully used for panelling and joinery.

INDIAN LAURELWOOD (*Terminalia tomentosa* Wight and Arn.). One of the finest and most beautiful of the new Indian timbers. It bears a general resemblance to walnut in colour and figure, but the character of the wood is distinctive and attractive on its own merit. It is hard and difficult to work and needs careful selection and matching, but is worth all reasonable trouble and expense. The panelling constructed in this timber for the Central Hall of the India Pavilion of the British Empire Exhibition, 1924, when the timber was used in veneer on a backing of Moulmein cedar, is an example of the proved successful use of the wood for the purpose. Sections of this panelling, shown at the Timber Exhibition at the Imperial Institute in 1928 by Messrs. W. W. Howard Bros. & Co., were in perfect condition.

BURMA PADAUK (*Pterocarpus macrocarpus* Kurz) is closely related to the more striking and better-known Andaman Padauk, from which it differs chiefly in its more subdued reddish-brown colour. The figured material is of exceptional beauty and dignity, and must be regarded as one of the best panelling timbers available. The wood takes an excellent polish and has good technical qualities, although it is hard and a little difficult to work.

INDIAN SILVER GREYWOOD (*Terminalia bialata* Wall.). An ornamental timber with a bold figure which renders it specially suitable for large panels. The varying colour (yellowish-grey to grey-brown) is one of the characteristic features of the wood ; the tones have little or no resemblance to stained " greywood," but are quite permanent and render the wood a useful substitute for the popular walnut. The working and polishing qualities are satisfactory, but care is needed in gluing. The wood is now being used by the London, Midland and Scottish Railway Company for the internal decoration of " luxury " coaches.

It is suggested as a useful alternative to the walnut at present so much used for the panelled backgrounds of shop windows. The panelling of the Georgian Dining Room of the India Pavilion at Wembley was a notable instance of the use of this wood.

White Bombway (*Terminalia procera* Roxb.). This timber is as yet little known in this country, but is an attractive decorative wood which works and finishes well. It is a lustrous yellowish-grey to light brown wood, often with darker streaks, and is close and even grained. It is comparatively cheap and supplies a decorative material for less important work.

Kokko (*Albizzia Lebbek* Benth.) is a handsome lustrous brown timber showing a considerable variety in colour and markings. Finely figured material with parallel bands is available, as is shown in the remarkable panelling in this wood at India House. Kokko is hard, has a fine texture with somewhat open pores and stands well. It needs careful finishing, but an excellent surface and polish are obtainable.

Andaman Padauk (*Pterocarpus dalbergioides* Roxb.). The handsome dark crimson variety of this timber is often beautifully figured and forms a decorative wood of the first class, though the more brightly coloured timber does not suit all tastes. The colour, however, mellows with time to a fine golden brown, and useful examples of the appearance of the wood after 30–40 years' standing are afforded by the fittings in All Saints' Church, Paddington, and the panelling of the Jehangier Hall at the Imperial Institute, South Kensington. A fine effect is produced in suitable cases when panelling in this timber is relieved with ebony mouldings or beadings. The timber is officially recognised as fire-resisting.

Teak (*Tectona grandis* L.). The decorative value of selected teak is not fully recognised, the familiar more or less plain variety usually being regarded as expressing the full extent of the ornamental capabilities of the wood. The selected timber used in constructing the new show-cases in the Indian Section of the Imperial Institute illustrates the value of even moderately figured wood. Highly figured material, however, is also available and is one of the most ornamental timbers for high-class panelling. Objection is sometimes raised to the characteristic odour of freshly worked teak ; the smell is not permanent and should not be regarded as a drawback to the use of the wood for internal work.

INDIAN WHITE MAHOGANY (*Canarium euphyllum* Kurz) is one of the most useful of the Indian woods if quarter-sawn ; the flat-sawn timber is apt to " move " unless used for fixed work. Quarter-sawn stock resembles a pale, banded mahogany. The wood is mild and straight grained, works well and stains to any desired colour ; the unstained, clear, polished timber, however, has a very good appearance, and is recommended as worth consideration for domestic decorative work. The timber needs careful finishing, but no special difficulty is involved. Botanically, it does not belong to the mahogany family.

WHITE CHUGLAM (*Terminalia bialata* Wall.) is a pale yellow-grey mottled wood with good and easy working qualities. It stains and polishes well and is very satisfactory for light-coloured panelling and for ornamental structural work.

GURJUN (*Dipterocarpus* spp.). A pale reddish-brown timber of bright clean appearance which works excellently and polishes well, especially good results being obtained with a dull " egg-shell " finish. It is chiefly known as a flooring wood and has been little used for panelling, but is well worth attention for this purpose.

BURMA MAHOGANY (*Pentace burmanica* Kurz). This valuable wood is worth full consideration for decorative work. It does not belong to the mahogany family, but resembles Cuban mahogany in general appearance ; figured material is often obtainable. The working and polishing qualities are satisfactory, but carefully seasoned stock is essential. Panelling at Sidney Sussex College Extension, Cambridge, is carried out in this wood.

EAST INDIAN ROSEWOOD (*Dalbergia latifolia* Roxb.). This fine decorative wood is perhaps too dark in colour for prevailing fashion, but it should be considered for use in special cases, as it is one of the most ornamental timbers available.

EAST INDIAN (CEYLON) SATINWOOD (*Chloroxylon*

Swietenia DC.) is too well known and valued to need more than mention.

Australian and New Zealand Timbers

BLACK BEAN (*Castanospermum australe* A. Cunn.). Selected figured material of this timber is probably the finest decorative hardwood of Australia. It is dark walnut in colour, variegated with lighter and darker bands, and works and finishes well. If used in the solid, quarter-sawn material should be used ; the highly decorative flat-sawn timber is quite satisfactory as veneer. The timber is particularly well suited for doors and panelling, for which purposes it has been used in the new offices of *Punch.*

BLACKWOOD (*Acacia melanoxylon* R.Br.). The figured material (especially the " fiddle-back " variety) of this Australian wood is strikingly ornamental, and, although not common in trade, is well known and obtainable on enquiry. It is used in veneer only. The plain blackwood, employed very successfully for flooring, has a quite different appearance.

MOUNTAIN ASH (*Eucalyptus* sp.), in its figured or flowery varieties, is one of the most beautiful of Australian woods. It is a bright, light-coloured timber with pale brown elaborate figuring, and makes handsome panels which can be effectively stained. The figured material is not common but is well known and usually available as veneer in London.

QUEENSLAND WALNUT (*Endiandra Palmerstonii* (Bail.) C. T. White). During recent years this timber has been widely used in the United States, where it is appreciated for its decorative value and working qualities. It is pale chocolate-brown to greenish-brown in colour and presents a great variety of attractive figuring. Elaborately ornamental timber is obtained from the butts and rootstocks, but does not yet appear to have reached this country in quantity. The working and polishing qualities are quite satisfactory, especially if quarter-sawn stock is used. The timber is an excellent alternative to American walnut and forms very attractive panelling. The decorative effect on the whole is subdued.

SILKY OAK (*Cardwellia sublimis* F. Muell.). A clear, bright, light brown timber with a characteristic spangled or wavy figure resulting from the broad and well-marked medullary rays. It forms excellent panelling when used in veneer, which enables useful widths to be built up. The working qualities are quite satisfactory.

QUEENSLAND MAPLE (*Flindersia Brayleyana* F. Muell.). A highly lustrous, pale pink timber of which selected figured material from the butts and rootstocks is of special decorative value. Used as veneer.

TASMANIAN OAK and VICTORIAN OAK, closely related Eucalyptus timbers, are valuable where a clean, plain oak effect is required for panelling, skirtings and mouldings. The characteristic figure of true oak is absent. It is important that the timber should be carefully selected from thoroughly seasoned stock.

RIMU (*Dacrydium cupressinum* Soland.) is one of the few decorative woods of New Zealand available in this country. It is a softwood, strong, close-grained, reddish-brown in colour with lighter and darker bandings and streaks. It is easily worked.

West African Timbers

In addition to the African mahoganies mentioned above, the three following timbers from British West Africa (chiefly Nigeria) are worth full consideration for panelling:

NIGERIAN WALNUT (*Lovoa Klaineana* Pierre ex Sprague). Also known as African walnut and Benin walnut. Examples of the decorative use of this timber are the panelling of the Lecture Hall at Emmanuel College, Cambridge, and the panelling of show-rooms in Messrs. Liberty and Co.'s Store, Regent Street, London. It is a walnut-brown wood usually showing a golden-brown lustre with a dark brown or black streaked and banded figure. It is not difficult to work, and the usual technical qualities are quite satisfactory; excellent results are obtained with both high and dull polishing. Planks up to 24 in. wide are available. Recognised by the London County Council as fire-resistant.

IROKO OR AFRICAN TEAK (*Chlorophora excelsa* Benth. and Hook.). This timber, usually employed for other purposes, has distinct decorative value and selected material might well be used for panelling. It is now recognised by the London County Council as fire-resistant. The wood is pale to dark brown in colour, showing parallel bands of different tones, is somewhat cross-grained and requires care in finishing. The wood is not related to true teak and bears little resemblance to that wood.

WEST AFRICAN SATINWOOD (*Afrormosia* sp.), sometimes known as Ainyeran (Anyeran), is a fine decorative wood from Nigeria, well figured material bearing a resemblance to East Indian satinwood. The wood is not always in stock but is well known to firms dealing in West African timbers.

Canadian Timbers

The chief available Canadian woods suitable for decorative work are :

CANADIAN ROCK MAPLE (*Acer saccharum* Marsh.). The ornamental value of the bird's-eye and other figured varieties of this wood are too well known to need reference other than to the necessity for careful selection on account of the variation met with in commercial stocks.

CANADIAN BIRCH (*Betula lutea* Michaux). Decorative material of great beauty is obtained by appropriate conversion of this timber. The rotary-cut veneer is an excellent wood for panelling and is well suited for high-class domestic work.

BRITISH COLUMBIA DOUGLAS FIR or BRITISH COLUMBIA PINE (*Pseudotsuga taxifolia* Brit.). Probably the most characteristic of Canadian timbers. The highly figured rotary-cut material is now widely used for panelling of rooms and doors in this country, though the boldness of the figure, especially after staining, may sometimes be considered excessive. When used in conjunction with edge-grain stock for framing, an excellent result is obtained, as may be seen in several examples of cases made for panoramas in the Exhibition Galleries of the Imperial Institute.

B.C. WESTERN HEMLOCK (*Tsuga heterophylla* Sarg.). A British Columbia softwood having a general resemblance to Douglas fir but pale yellow-grey in colour. Rotary-cut veneer or flat-sawn timber is highly figured and well suited for decorative panelling. The wood gives excellent results with proprietary staining processes and might be more widely used when so treated.

B.C. WESTERN RED CEDAR (*Thuja plicata* D. Don). A fine softwood from British Columbia, pale purple-brown in colour, and giving a pleasing, quiet effect when used for panelling. When flat-sawn or rotary cut it has a strong, wavy figure, and such material is very decorative. The wood is somewhat soft and should not be used for work exposed to rough usage.

West Indian Timbers

In addition to mahogany, two woods of British Honduras are worth special mention for decorative work.

BRITISH HONDURAS ROSEWOOD (*Dalbergia stevensonii* Standl.), which is allied to East Indian rosewood, is a timber of great beauty, as is well shown in the panelling of an exhibition case in the British Honduras Court at the Imperial Institute. Next to figured mahogany, it is probably the finest decorative wood of the British West Indies.

BRITISH HONDURAS CEDAR (*Cedrela mexicana* Roem.) is perhaps the best of the Central American cedars. It is a well-known aromatic wood admirably adapted for plain panelling.

BRITISH GUIANA CRABWOOD (*Carapa guianensis* Aubl.) is a plain, bright, mahogany-like timber which has been successfully used at the Imperial Institute for the construction of an ornamental screen and is well worth attention for decorative work. It is essential that quarter-sawn and carefully seasoned material should be used. The timber is recognised as fire-resistant by the London County Council.

North Borneo Timbers

SERAYAH (SERIAH), derived from species of Shorea, is marketed in two varieties, viz. red serayah and white serayah, and is now becoming well known in this country, especially for the decoration and internal fittings of railway carriages. The red variety is perhaps to be preferred and is sometimes described as Borneo mahogany and Borneo cedar. Both varieties are plain but attractive woods resembling mahogany or cedar, and form excellent quiet panelling. The working qualities are quite satisfactory.

TIMBERS FOR STAIRCASES

At both the Empire Timber Exhibition (1920) and the Wembley Exhibition (1924) specially constructed staircases were among the most important examples of the use of Empire woods for structural and decorative purposes. Staircases offer special opportunities for the use of a variety of timbers in consequence of the varying requirements for different parts of the structure, e.g. the carcassing, ornamental panelling, turnery, carving, stair treads and risers. For all these uses it is possible to recommend Empire woods as entirely satisfactory. At the Exhibitions mentioned, Andaman Padauk and Indian Silver greywood were used and found very successful both as regards appearance and standing qualities. Most of the woods recommended above for panelling would also be found suitable for the decorative work and turnery of staircases; Andaman Padauk, Burma Padauk, Indian Laurel, figured Teak, Burma mahogany, Kokko, the African and Honduras mahoganies, Queensland walnut, Silky oak and Nigerian walnut are specially suggested. For treads and risers Gurjun, Canadian maple, and Australian blackwood and Jarrah may be mentioned. Jarrah, Karri and British Guiana Mora (*Dimorphandra Mora* Benth. and Hook.), are specially adapted for the treads of staircases subject to hard usage.

Special attention is called to the fine results obtained with Andaman Padauk for carved balusters and newel posts. The beautifully carved balusters surrounding the gallery in the central hall at India House have been carried out in a pale variety of the wood, and it is difficult to overstate the decorative effect.

For certain types of staircases fire-resistant woods are essential. In this connection reference is made to the timbers mentioned above as having been recently approved by the London County Council as fire-resistant: teak, jarrah and karri are similarly accepted.

TIMBERS FOR JOINERY

Timbers, both hardwoods and softwoods, satisfactory in all respects for the main types of joinery, viz. doors, windows, sashes and sills (as well as for office and similar heavy fittings), may be obtained from Empire sources, and the usual requirements for materials for high-class work, medium grade and cheaper work can also be satisfied. A series of eight high-class double and single doors, designed by distinguished architects and manufactured by Messrs. Holloway Bros. (London) Ltd., from selected Empire woods was shown at the Imperial Institute Empire Timber Exhibition, 1928, and illustrated the suitability of the following woods for the purpose: Andaman Padauk, Indian Silver greywood, White Chuglam, Indian Laurelwood, Indian White mahogany, White Bombway, Kokko and Nigerian walnut. Other timbers suggested for similar classes of work are: Indian rosewood (used for the front doors of India House), Andaman Padauk (inside doors at India House), Australian blackbean, Australian walnut, Silky oak and Burma mahogany, in addition to mahoganies.

For doors of good appearance and capable of hard usage Burma teak, White Chuglam, Honduras mahogany, British Columbia Douglas Fir and Iroko are recommended. Doors made from the first three timbers mentioned, and intended for use in public baths and hospitals, were exhibited by Messrs. Holliday and Greenwood Ltd. at the Exhibition already mentioned.

IROKO (African teak) is an admirable timber for high-class joinery and is particularly well suited for window frames, sashes and outside doors on account of its durability and resistance to the weather. Frames, sashes and outside doors, manufactured experimentally from this timber by Messrs. Holliday and Greenwood Ltd., were fitted into a store at the Imperial Institute in 1918 and received no paint or other protection. In spite of the exposed position of the building the joinery mentioned is in excellent condition.

TASMANIAN OAK and VICTORIAN OAK (Eucalyptus woods) also are valuable joinery timbers, useful as alternatives to plain oak for skirtings, framing, etc. The Indian WHITE CHUGLAM is also suitable for the same purpose, and is so employed at India House.

GREENHEART (*Ocotea Rodiei* Mez), the characteristic timber of British Guiana, has hitherto been known mainly for its use for marine piling and dock work. Sawn timber in a variety of sizes is now available, and there is little doubt that this durable wood, which works well, would form an excellent material for outside door and window joinery.

No special mention of TEAK is necessary since it is universally recognised as a joinery timber of the highest class for both interior and exterior work. GURJUN (*Dipterocarpus* spp.), another Indian timber, is also valuable for outside doors and other exposed work.

Reference may be made to the Indian timber PYINMA (*Lagerstroemia speciosa* Kurz), which is recommended as particularly suitable for most classes of joinery where a wood of good appearance is required at a moderate cost. It is strong and durable, comparatively light, and easy to work. Occasionally, figured material is available and this is well adapted for door panels and other ornamental work. The timber has been successfully used for a panorama case at the Imperial Institute.

A number of Canadian softwoods form excellent material for the medium and cheaper classes of joinery. BRITISH COLUMBIA DOUGLAS FIR as rotary-cut veneer for panelling, combined with edge-grain stock for styles and rails, is now widely used for doors. B. C. WESTERN HEMLOCK, though not so strong a timber, would be entirely satisfactory for the same purpose and has a distinctive and pleasing colour. WESTERN RED CEDAR, also from British Columbia, forms handsome doors, but the surface is somewhat easily dented and the wood should not be used for joinery likely to receive hard wear. The timber, however, is very durable when exposed to the weather. CANADIAN RED PINE (*Pinus resinosa* Ait.), often marketed as Ottawa Red Pine and Quebec Red Pine, among Empire softwoods is the timber which resembles most closely

Baltic redwood both in appearance and character, and forms a useful substitute for that wood. The less expensive grades of BRITISH COLUMBIA SITKA SPRUCE (*Picea sitchensis* Trautv. and Mey.) and WHITE or YELLOW PINE (*Pinus Strobus* L.), and also WESTERN WHITE PINE (*Pinus monticola* D. Don) are valuable joinery woods. BORNEO TEAK is well suited for framing and joinery exposed to the weather, as also is BORNEO CAMPHOR WOOD (*Dryobalanops aromatica* Gaertn. f.), sometimes offered as mahoborn teak.

For sills and treads subject to severe exposure or usage, Teak, Iroko, Greenheart, Mora and Borneo teak are valuable woods. For exceptionally severe conditions, BURMESE PYINKADO (*Xylia dolabriformis* Benth.) is perhaps unrivalled. Attention is called to the fire-resisting timbers mentioned above.

TIMBERS FOR FLOORING

Since the war, much experience has been gained by builders and flooring manufacturers in the use of Empire woods for flooring, and it is now possible to recommend with confidence a number of timbers for this purpose as alternatives to the invaluable oak. In addition to being wholly satisfactory as regards the special qualities required in flooring timbers, the woods vary widely in appearance, colour and ornamental character, and afford a welcome choice of material when variants from the standard types of flooring are desired. Such woods are now freely used and there is no doubt of their satisfactory character provided fully seasoned and accurately manufactured stock is employed. These desiderata are essential, as also is the satisfactory preparation and condition of the sub-floor. Strips and blocks are available and combinations of the timbers have been successfully used in parquetry flooring.

CANADIAN HARD MAPLE is one of the finest decorative flooring woods and requires no more than mention. TASMANIAN and VICTORIAN OAKS form excellent utility flooring employed either as open flooring or covered with linoleum or rubber. Used without covering the woods give a particularly clean effect and they can be stained if desired. They should be cheaper than other woods mentioned.

JARRAH (*Eucalyptus marginata* Sm.) makes an excellent red-brown floor of great durability; it is available in blocks and strips. KARRI (*Eucalyptus diversicolor* F. Muell.) is also a valuable flooring wood of good appearance and great durability. AUSTRALIAN BLACKWOOD, supplied chiefly as strips, occurs in shades of chocolate brown, and forms a handsome, durable floor. QUEENSLAND SILKY OAK is also an attractive flooring timber. Recently, AUSTRALIAN WALNUT has been used for flooring and appears to be entirely satisfactory.

Among Indian woods, TEAK is a well-known flooring timber with excellent wearing qualities, and ANDAMAN PADAUK may be similarly described with additional reference to its striking appearance. KOKKO has also been used for flooring. GURJUN and KOKKO are the flooring timbers used at India House. Both are excellent materials for the purpose. GURJUN is especially durable and can be worked to a fine lustrous surface. It is relatively silent in use and is well adapted for ball-rooms. INDIAN LAURELWOOD and SILVER GREYWOOD have also been used for flooring in private houses. Examples of parquetry floorings made from most of these timbers were shown by Messrs. W. W. Howard Bros. & Co. at the Imperial Institute Timber Exhibition, 1928.

Carefully selected material of BRITISH COLUMBIA DOUGLAS FIR used as edge-grain blocks is well known as making a hard-wearing floor of good appearance. A timber recently offered as flooring strips and worth careful consideration is BRITISH GUIANA GREENHEART. The appearance is excellent and there can be no doubt as to satisfactory wearing qualities. Probably the "newest" Empire woods for flooring are RHODESIAN TEAK (*Baikiaea plurijuga* Harms.) and RHODESIAN MAHOGANY (*Copaifera coleosperma* Benth.), both of which appear to be satisfactory for the purpose.

SOFTWOODS FOR CARCASSING AND GENERAL CONSTRUCTION

Softwoods from Empire sources available in this country for constructional work, e.g. beams, roofs, joists and general carpentery, are confined to a group of Canadian timbers comprising several first-class species which may be used with confidence as alternatives to Baltic yellow (red) deal, Baltic white deal, and, in one instance, in place of American pitch pine for many purposes. These timbers are:

British Columbia Douglas Fir, a constructional timber of high reputation on account of its large dimensions, great strength, freedom from defects, good working qualities and relatively low cost. It is readily available and is a useful substitute for Baltic yellow deal, while selected material can take the place of pitch pine for shoring timbers and similar heavy work. It should not be used in unventilated positions. The timber is somewhat more difficult to work than Baltic yellow deal and does not take paint well.

Canadian Red Pine is a useful substitute for yellow deal. It is hard and durable, takes paints well and is suitable for outdoor work if required. British Columbia Western Hemlock is also a useful timber for general construction work though not so strong as Douglas fir. It is available in large sizes, has good working qualities and takes paints well. It is stated to be vermin proof.

Quebec Spruce and St. John Spruce (*Picea* spp.) and British Columbia Sitka or Silver Spruce form useful alternatives to Baltic white deal. The Sitka spruce is available in large sizes and has an excellent appearance ; the price, however, is somewhat high and the wood is not used largely for constructional purposes.

Canadian Yellow or White Pine (Quebec Pine) is well known for superior carpentery but is now very expensive. A useful alternative is Western White Pine from British Columbia, which is now on the market.

Timbers for Domestic Offices

Several Empire timbers are well suited for the wooden fixtures and other equipment of kitchens and sculleries of private houses, hotels and restaurants, and public institutions. Both softwoods and hardwoods are available. The former comprise excellent substitutes for the Baltic softwoods usually employed for the less expensive type of fittings, and with due selection are capable of being used either varnished or painted, or as the basis of the hard cellulose varnishes and enamels. Among softwoods may be mentioned BRITISH COLUMBIA DOUGLAS FIR, which should be used plain, varnished, wax finished or stained ; it is valuable for its hardness and durability.

BRITISH COLUMBIA WESTERN HEMLOCK is well suited for dressers, cupboards and similar joinery. CANADIAN RED PINE serves well for shelving, benches, tables, etc., in place of Baltic red deal.

QUEBEC SPRUCE and ST. JOHN SPRUCE form useful substitutes for Baltic white deal, especially where the latter is used for surfaces required to be kept " white " by scouring. They are also well suited for painting, staining and cellulose enamelling. For superior work in softwoods CANADIAN WHITE (yellow) PINE and grades of SITKA SPRUCE are suggested, and also the WESTERN WHITE PINE from British Columbia. Attention is also drawn to NEW ZEALAND KAURI PINE (*Agathis australis* Salisb.) for special purposes where a timber of fine uniform texture and of exceptional width is required ; prices are somewhat high and supplies are restricted, although sufficient to meet likely demands.

Hardwoods which may be mentioned for these purposes are : TASMANIAN OAK and VICTORIAN OAK, especially valuable for domestic fittings on account of their clean appearance. EAST INDIAN TEAK, well known and valued for scullery table tops, benches and purposes where hard-wearing qualities and resistance to wet are required ; also for plate racks and draining boards. IROKO is also strongly recommended for these purposes ; it has the merit of being cheaper than teak.

The value of CANADIAN HARD MAPLE and CANADIAN YELLOW BIRCH for domestic office equipment is well known.

TIMBERS FOR OTHER PURPOSES

The construction and fitting of stabling affords opportunities for the use of Empire woods. For stall partitions DOUGLAS FIR, CANADIAN ROCK ELM, EAST INDIAN TEAK, IROKO and JARRAH are suggested. CANADIAN MAPLE and CANADIAN ROCK ELM are suitable for feeding troughs and racks. For structural work DOUGLAS FIR or TEAK might be used, according to the type of building concerned.

TEAK, IROKO and GREENHEART would be admirable woods for outbuildings, summer-houses and other garden structures on account of their durability and good appearance. The use of wooden shingles for the roofs of garden buildings suggests the value of WESTERN RED CEDAR shingles for this purpose. Red cedar is remarkably durable and is the principal shingle timber of Canada.

The Nigerian timber OBECHE (*Triplochiton scleroxylon* K. Schum.), also offered as African whitewood and Larana, is an excellent, pale-coloured, soft hardwood valuable for a variety of construction work. It has good working and painting qualities and stands well.

NOTES

Imperial Institute Exhibition of British Empire Minerals.—A special exhibition illustrating the Mineral Resources of the British Empire was opened at the Imperial Institute Galleries on February 17, 1931, by the Right Hon. L. S. Amery, M.P., its object being to show the immense quantity and great variety of minerals that are available within the Empire.

The exhibition will be open until the end of April, and during its continuance it should prove of great educational value not only to the general public but also to all those interested in mining as well as students of economics.

In arranging and collecting exhibits the Institute has been greatly assisted by the overseas governments concerned. These sent not only considerably over 2,000 mineral specimens, which were supplemented by others from the Imperial Institute collections, but also large numbers of models, maps, photographs, diagrams and flow sheets of mining and metallurgical operations.

Recently developed deposits are represented by the copper ores of Northern Rhodesia, the manganese ore of Postmasburg, platinum ores and concentrates from the Transvaal Bushveld, coals from Tanganyika and asbestos from India.

The exhibits of gold nuggets and other samples from Western Australia, and of gems and gemstones from Ceylon, South-West Africa, Gold Coast, India and Australia make very attractive displays.

To illustrate the application of the minerals to industrial uses a large number of British manufactured and semi-manufactured products are being shown with them.

Interesting features among the exhibits are the fine scenic panoramas, the illuminated mine models of Roan Antelope and Mufulira in Northern Rhodesia, and special cinema films illustrating the mineral industry of various parts of the Empire.

Lectures on Empire minerals and on the mineral resources of India were given on February 19 and March 12 by Sir Robert Horne and Sir Edwin Pascoe, respectively.

Imperial Institute Publications on Mineral Resources.—Two new volumes in the series of monographs, dealing with (1) Zinc, and (2) Tantalum and Niobium, and a pamphlet on the Mineral Position of the British Empire, have recently been issued by H.M. Stationery Office.

Zinc (2nd Edition, 193 pp., price 3s. net). The importance of the zinc industry can be realised when it is known that the world produces about 1,400,000 tons of the metal per year, the ores being mined in nearly forty countries. Zinc is employed in numerous forms in most branches of industry and demand for it in recent years has been steadily increasing.

The monograph forms a very useful handbook, for it contains a complete and up-to-date account of the industry, with a great deal of statistical information on production of and trade in zinc ores, the metal, and products derived from them.

The general section (23 pp.) describes the ores of zinc and their occurrence and the various metallurgical processes for reducing the metal from them; some of the numerous uses of zinc, including those of the metal in various forms and those in the form of alloys, such as brasses, antifriction metals, nickel silvers, turbadium bronze, die-casting and "electro" alloys and hard solders; the "galvanising" or zinc-coating of iron; pigments and salts.

The second section of the book (60 pp.) fully describes the principal zinc deposits in different countries of the British Empire, showing that there are ample resources, many large deposits being of recent development or exploitation.

The last section deals in a similar manner with the principal zinc deposits of foreign countries.

Tantalum and Niobium (25 pp., price 6*d.*). The development of "wireless" in the United States in recent years and, with this, a demand for a cheap and efficient means of converting alternating electric current into direct, drew attention to tantalum as a suitable electrode in an electrolytic cell for rectification, which became very extensively used and the tantalum industry thus established. Extensive use of tantalum in radio valves followed, with development of its employment for numerous other chemical, physical and commercial purposes. The latest use is in the manufacture of spinnerets used in the artificial silk industry.

The closely related metal, niobium, has been shown to possess similar properties to those of tantalum, but it has not yet come into commercial use.

The Institute's monograph gives a considerable amount of information about the properties and uses of the two metals, but it is mainly devoted to the more important occurrences of their ores throughout the world, in which Western Australia and North Australia are the chief sources of supply.

A Survey of the Mineral Position of the British Empire (121 pp., price 2*s.* net). This volume was produced with the object of supplying a handbook which could be used by visitors to the Imperial Institute Exhibition of Empire Minerals (see p. 61).

It gives in a very handy form an account of the present mineral position of thirty-four British Dominions, Colonies, Protectorates and Mandated Territories, including production and trade in all the principal minerals.

Apart from its use as a handbook to the Exhibition, it will be found to be a very convenient source of information by all those interested in the study of the Empire's resources of minerals, which, in the case of about four-fifths of those required under modern conditions, could be made to supply her wants. In the case of seven mineral substances the Empire largely, if not entirely, supplies the rest of the world.

The Tree Mallow and its Fibre.—The tree mallow (*Lavatera arborea* L.) is a plant which occurs on the coast of many parts of Great Britain and Ireland. During 1857 to 1860 some experiments were carried out by Mr. John Hogg in the south-east of Co. Durham with seeds obtained from the south coast of Ireland and the results were published in the *Journal of the Society of Arts*, 1860, Vol. VIII, pp. 619–620. It was found that the plants grew well and required no special care in cultivation ; they were very resistant to cold and apparently would not be destroyed except by an intense frost. The bark of the plant varied from $\frac{1}{4}$ to $\frac{5}{16}$ in. in thickness and was of a very fibrous nature, and it was suggested that it might prove suitable for the manufacture of ropes, mats and similar articles. Mr. Hogg presented a sample of the stem with its fibrous bark to the Museum of Economic Botany at Kew, and found that there were already in that Museum specimens of the prepared fibre of *L. arborea* and of rope made from it which had been received from Madeira, and also some fibre of the same species from Ireland.

In a subsequent communication (*Journal of the Society of Arts*, 1861, Vol. IX, p. 540), Mr. Hogg referred to the manufacture of rope from *L. arborea* fibre. He states that the rope was "of a coarse texture, but very strong, and the ropemaker, who prepared it last December, told me that, as it received a greater degree of strength by being immersed in water, he thought it would prove of great service for ship purposes. But he was of opinion that it was less capable of receiving a bright polish, like hempen cord, and that it was not so well adapted to the finer sorts of cord, etc."

Mr. Hogg added that the rope "was made with the fibre from a plant of only a single year's growth, and since the plant itself does not attain its full maturity until two years old, I think the fibre would be improved, and probably become less coarse, if it were not used until it had arrived at that age."

It is clear from the above that *Lavatera arborea* has long been known as a British plant bearing an inner bark of a very fibrous character. It does not appear, however, that the fibre has ever been prepared on a commercial scale for the market. In view of this the Imperial Institute considered it of interest to examine some freshly collected specimens of the plant, which were kindly forwarded from Jersey by Mr. R. L. Proudlock.

The stems possessed a fibrous bark from $\frac{1}{8}$ in. to $\frac{3}{16}$ in. in thickness, of slightly interlaced structure. A portion of the bark was subjected to a combing treatment with a series of steel combs, and the fibre thus separated was washed well with water, air-dried, and finally brushed. This fibre was fairly lustrous, white, rather coarse and woody, and could be extracted from the bark in strands up to $2\frac{1}{2}$ ft. in length. Attempts made to subdivide the coarse strands were not successful, as the fibre easily broke down into pieces only a few inches in length.

In a second experiment, the bark was allowed to stand in a cold 1 per cent. solution of sodium carbonate for four days. At the conclusion of this period the partly softened bark was withdrawn from the solution and the non-fibrous portion removed by scraping and washing. The coarse fibre thus obtained was then cleaned by a gentle combing and brushing treatment; it was of a pale brown colour, but was otherwise generally of similar character to that prepared mechanically from the bark in the first experiment.

These results show that on simple mechanical treatment the bark of the *L. arborea* plants received from Jersey yields long strands of white, harsh, rather coarse fibre, of a somewhat woody nature. The product is not very strong and is much inferior to jute, so that judging from the present experiments it is doubtful whether it could be profitably produced on commercial lines in competition with the various fibres which are already available in sufficient quantity for the needs of the market.

The Feeding Value of Shea Nut Cake.—Shea nut cake or meal is the residue obtained after the removal of the oil from shea nuts by crushing in hydraulic presses or extracting by solvents. It is used in the manufacture of compound feeding-cakes, in which it may be present to the extent of 5 per cent. For this purpose one of the largest makers of feeding-cakes uses as much as 3,000 to 4,000 tons per annum.

Shea nut cake possesses a bitter, astringent taste and contains saponin and tannin. Its composition is shown in the following table, from which it is seen that it should have a moderate value as a feeding-stuff:

—	Shea Nut Cake.			Shea Nut Meal.		
	1	2	3	4	5	6
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	10·25	9·50	9·95	13·1	9·76	12·70
Crude Proteins	11·81	11·90	12·13	15·6	12·39	12·37
Fat	8·25	7·00	6·50	3·2	2·93	4·73
Carbohydrates, etc. (by difference)	57·94	58·60	60·74	56·8	61·30	57·67
Crude Fibre	6·50	7·10	4·78	5·4	7·46	6·48
Ash	5·25	5·90	5·90	5·9	6·16	6·05
Nutrient Ratio	1 : 6·5	1 : 6·3	1 : 6·2	1 : 4·1	1 : 5·5	1 : 5·5
Food Units	108	106	107	104	100	100

1. *Cake as used in feeding trial on heifers* (*see p.* 67).
2. *Average analysis. Figures supplied by Messrs. Lever Bros. Ltd.*
3 *and* 6. *Smetham and Dodd. "The Valuation of Feeding Stuffs."*
4. *Meal prepared at Imperial Institute from Shea nuts from Sudan.*
5. *Bolton, "Oils, Fats and Fatty Foods," p.* 275.

The carbohydrates, which amount to about 60 per cent. of the cake, contain a considerable proportion of sugars, the presence of which adds to the value of the material. As regards the saponin, the Imperial Institute has been informed that experimental work on its nature and toxicity has recently been carried out in this country. These investigations are based on the work of Kofler, which depends on a relation between the hæmolytic activity of saponin (that is, the power of destroying red-blood corpuscles and liberating hæmoglobin) and its froth-forming qualities. From his observations Kofler arrived at the conclusion that for a saponin innocuous to animals, the ratio of the hæmolytic activity to the frothing power should not exceed 0·5 to 1·0. Using the above relation as a basis, tests on shea nut cake resulted in the conclusion that it does contain a saponin-like body exhibiting the well-known characteristics of frothing and of hæmolysis, but that according to Kofler's ratio it would not be poisonous to animals.

From time to time trials have been conducted to determine the feeding value of shea nut cake. M. Ripper (*Zeits. landw. Versuchswesen in Oesterreich*, 1903, **6**, 620) found that this material was as satisfactory as palm kernel cake as a feed for milch cows, when compared in relation to price and feeding value, and that it produced no injurious effects on the health of the animals when fed at the daily rate of 1·5 kilograms per 500 kilograms live weight.

Feeding trials with the cake are mentioned by Em. Perrot in " Le Karité " (*Les Végétaux Utiles de l'Afrique Tropicale Française*, Fasc. II, Paris, 1907, pp. 87–91). These trials were carried out on rabbits and sheep by M. Dechambre at the École National d'Agriculture, Grignon, France. The rabbits are stated to have accepted the cake and consumed it without ill effects. In the case of the sheep, although one animal refused the cake, two others accepted it and were given various quantities ranging from 50 grams each per diem at the beginning of the experiment, which lasted for 46 days, to 450 grams per diem towards the end. The sheep weighed 42 and 34 kilograms respectively at the commencement of the experiment, and at the close were found to have gained 6 and 5 kilograms respectively. The conclusions drawn from the tests were as follows : " The trials indicated that shea nut cake can be fed to rabbits and sheep, and no ill effects were observed in the latter up to an amount of 450 grams per diem. Very little liking, however, was shown for the cake and even animals which showed no repugnance would take a considerable time to get used to it." It may be pointed out, as regards the statement that animals do not find the cake palatable, that the same observations have been made frequently with reference to palm kernel cake.

Last year a firm of seed-crushers in England conducted on their experimental farm a test, which had as its primary object to determine whether, by feeding unusually large quantities of shea nut cake, symptoms of poisoning could be produced in cattle. According to the report on this experiment, kindly furnished to the Imperial Institute by the firm, two groups of heifers, four in each group, were taken and fed on a control ration until accustomed. The control ration was composed of: hay 14 lb., roots 10 lb., crushed oats 3 lb., maize meal 3 lb., palm kernel cake 8 lb. When the cattle had become accustomed to the feed, 2 lb. of shea nut cake was introduced into the rations of one group in place of an equal weight of maize meal. This was readily taken and at the end of a week a further 2 lb. per head of shea nut cake was added in place of 1 lb. of maize meal and 1 lb. of crushed oats. Although the ration containing 4 lb. of shea nut cake was readily taken, it was remarked that during the fortnight succeeding the introduction of the shea nut cake this group did not look so bright in their coats as those on the control ration. It may also be pointed out that, although every care was taken to select two comparable groups of heifers, during the preliminary fortnight when both groups were receiving the control ration, the group subsequently given shea nut cake was not doing as well as the control group. At the end of the third week the remaining 2 lb. of crushed oats was replaced by shea nut cake, thus raising the total allowance of shea nut cake to 6 lb. per head per diem. This ration was fed for nine weeks, at the expiry of which the experiment was stopped. As the trial progressed, the difference between the two groups as regards coat and condition became more marked, and the inferiority of the shea nut cake group was confirmed on weighing the animals. Judged by the eye alone, the shea nut cake group appeared to be making but little progress during the three weeks previous to the last weighing. At the end of the test only one heifer in this group was fit for the butcher, whereas three of the control group were finished. It was determined at the end of the experiment, which lasted for eighty-four days, that the average daily live weight gain for the control group was 1·72 lb., while that of the shea nut cake group was 1·14 lb. The conclusions drawn from the results of this test are: (1) Shea nut cake is palatable and readily consumed, even up to an amount equal to almost half the ration of the concentrated food. (2) Although shea nut cake contains a saponin, this is obviously not poisonous to cattle. No harm resulted from feeding up to 6 lb. per head daily to fattening cattle, although this amount produces an unthrifty appearance. (3) The fattening value of shea nut cake when fed at the rate of 6 lb. per head daily is distinctly inferior to that of a mixture of equal parts of maize meal and oats. In connection with this test, the firm remarks that "Pending further tests on shea nut cake, when a more accurate idea of its feeding value may be obtained, it is safe to conclude that the cake can be fed quite freely to fattening cattle without harmful results, but that its feeding value is lower than its analysis would indicate. It should be pointed out that an unusually high proportion of shea nut cake was purposely fed in the above test, to ascertain whether it was a safe feeding material. It seems possible that the tannin present limits its feeding value when a large quantity is fed, but that if a more moderate proportion were used, so that there were less tannin present in the total ration, results more in line with its analysis would be obtained."

The same firm have also conducted a preliminary experiment in which pigs were given a ration containing 20 per cent. of shea nut cake. It was found that the pigs readily ate the cake and that the amount fed had a neutral action on the bowels but appeared to be incompletely digested.

The general conclusion to be drawn from the information available in literature and the results of recent feeding trials is that shea nut cake is not a good feeding-stuff for animals when used alone, but that it can be employed satisfactorily in the manufacture of compound feeding-cakes.

Hydnocarpus and Chaulmoogra Trees in Siam.—In view of the increased use being made of hydnocarpus and chaulmoogra oils in the treatment of leprosy, an account given in a recent *Technical and Scientific Supplement to the Record, Siam* (1930, No. 7), entitled "The Genera Hydnocarpus and Taraktogenos in Siam," of the occurrence in Siam of the trees yielding these oils is of particular interest. According to this paper, of which the following is a brief abstract, there are several species of these trees found in Siam, most of which are called by the native name of "krabao." Only the seeds of *H. anthelmintica* have, however, been exported up to the present.

H. anthelmintica has a wide distribution in Siam and is found in almost all parts of the country, except towards the south, where it does not seem to extend beyond latitude 8·50° N. The tree appears to have two different classes of habitat. The first, where it is found in the greatest abundance, is in the immediate vicinity of rivers and creeks, running through level, low-lying country, or at the edge of swamps. It occurs especially on land that is subject to flooding and grows in a sandy-loam soil. In favourable situations, it is frequently found in nearly pure groves of 80 to 90 trees. The tree may grow to a fairly large size, reaching a height of 20 to 25 metres and having a circumference at breast-height of 4·5 metres. The other habitat of *H. anthelmintica* is in mountainous regions, up to elevations of about 1,300 metres. Here it grows in the valleys, usually near streams, where, however, it is rarely, if ever, subject to flooding. As a rule the tree is very scattered in these mountain localities and is not found in nearly pure formation. Flowering is often irregular and takes place generally about January and continues for some months. There are usually many more male than female flowers. Under plantation conditions fruit is produced within six years from the date of sowing the seed, whilst under natural conditions the tree may take longer than this to fruit. Ripening occurs in August and September, but there seems to be no regular periodicity in fruiting. The average annual crop of a mature tree is about 200 fruits. Sometimes a much greater number are produced while, on the other hand, it is not uncommon to see mature trees bearing no fruit at all. The ripe fruits are more or less globular and measure from 25 to 47 cm. in circumference. They usually contain about 60 seeds immersed in a whitish, mealy pulp.

Only a comparatively small area has so far been tapped for the collection of the seeds for export. The chief supply is drawn from Menam Tachin, a delta branch of the Menam Chao Phya. The groves along the Menam Pesak have been utilised to a less extent. Along these two rivers it is estimated that there are 12,000 trees capable of giving an annual crop of 200,000 kilograms of seeds. This, however, is obviously an under-estimate, as in 1919–20 the export of seeds, drawn almost entirely from the first-named locality, reached as high a figure as 537,900 kilograms. Until 1907–08 the export remained small, generally below 24,000 kilograms. Since then, the annual export, though fluctuating, has only dropped below 60,000 kilograms on four occasions. The annual amount exported during the five years ended March 31, 1930, was approximately 226,620 kilograms (225 tons), valued at about £1,520. The bulk of the export goes to Hong Kong and other Chinese ports, a small amount occasionally going to Singapore. In recent years there has been a small quantity exported to other countries, viz. British Malaya, India, Philippine Islands, Union of South Africa and Portuguese South-East Africa. Some of the seed sent to China is probably transhipped to Japan. During the last year or two, some of the seeds have been crushed in Bangkok and the oil exported, the amount exported in 1929 being 1,570 kilograms. The seeds shipped to China are used chiefly in the treatment of leprosy and other skin diseases, and in recent years the seeds or preparations from them have been employed for the same purpose in Siam itself. Another species of *Hydnocarpus*, namely, *H. castanea*, is also found in Siam, but it does not occur in sufficient numbers in accessible localities to be of commercial importance.

There are four species of *Taraktogenos* recorded in Siam. *T. Kurzii* has been found in several provinces in Northern Siam and in those of Patalung and Pattani in the Peninsula. Nowhere does this species appear to be very abundant and most of the places where it occurs are not easily accessible. This tree usually grows in deep alluvial deposits on the banks of perennial streams, but occasionally it is found on the lower hill-slopes above the highest flood levels. It seems to prefer cool, moist alluvial sites. The tree is distributed in interrupted patches of a few trees or sometimes as isolated trees. It is most abundant in the valley of the Me Peng, a tributary of the Me Yom, about 40 kilometres to the south-west of Denchai. It is estimated that in this region there are some 5,000 mature trees capable of producing as much as 7 tons of fruits per annum. The maximum girth and height of the tree in normal situations are about 1·06 metres and 21 metres respectively. The flowering and fruiting seasons are rather irregular. Some trees flower in the hot weather of March and April ; some ripen in May and subsequent months. Some trees do not flower every year, but no regular periodicity has been established.

T. ilicifolia is undoubtedly the most abundant among the species of the two genera under consideration. It is found in Siam from Udawn and Utaradit southwards to the southern frontier of the Peninsula. This tree does not grow to a large size, and reaches only about 20 metres in height and 1 metre in circumference. It is most abundant in the dry evergreen type of forest, frequent in Central Siam, where it is sometimes the commonest tree. In the Dong Paya Yen forest, which has an area of 1,650 sq. kilometres, it has been estimated that there are probably about 20 million of these trees. Very little use is at present made of the tree. The seeds yield an oil which is solid at ordinary temperatures and which has been used with some success as a soap oil.

T. calvipetala grows in high evergreen forest. Its distribution is rather local, but where the tree occurs it is fairly plentiful. So far it has only been met in the provinces of Langsuan and Ranawng, and then in localities rather difficult of access. Nothing is known of the properties of the seeds. Still more local in its distribution is the fourth species, *T. serrata*, which is known only in the forests of the provinces of Pre and Prachuap and even there is not common.

During the past five years the oil from *H. anthelmintica* seeds has been employed with satisfactory results at Chiengmai Leper Asylum. The supplies are obtained from Bangkok and each consignment is analysed in the Government Laboratory before being used.

Tobacco-Growing in Australia.—The Select Committee of the House of Representatives, Commonwealth of Australia, appointed to enquire into and report on the position of the tobacco-growing industry in Australia, has presented its report, dated June 30, 1930. The terms of reference directed that special regard should be given to :

(*a*) The request of the growers, submitted to the Prime Minister at Canberra in May 1928, for a bounty on Australian-grown leaf.

(*b*) The alternative request of the growers, submitted on the same occasion, for an increase in the duty on imported leaf and a decrease in the excise duty on locally-grown leaf.

(*c*) As to whether the arrangement entered into between the Commonwealth Government, certain States, and the British-Australasian Tobacco Company, to carry out experiments in the growing of tobacco leaf in Australia, is in the best interests of the growers.

(*d*) As to whether, in the best interests of the growers, the arrangement should be altered so as to ensure that the Federal direction of experimental work should be made a permanent phase of the tobacco-growing industry in Australia.

It is of interest to note the following information from the evidence of Dr. A. C. D. Rivett, Chief Executive Officer of the Commonwealth Council of Scientific and Industrial Research :

" The introduction of the seed of tobacco and its first cultivation in Australia would appear to have taken place at least 75 years ago. It is possible that migrating gold-miners brought in seed and cultivated the crop for their own use. Certain it is that all of the older districts are situated at, or in the vicinity of, old gold diggings. On the other hand, it seems probable that much of the earlier extensive planting was for the purpose of making sheep dip. Once introduced, tobacco-growing undoubtedly received its first impetus in the decade 1860–70, during and immediately after the civil war in America, when leaf imports were greatly restricted.

" The census records show that tobacco culture in Australia has undergone marked fluctuations. It is ranked as one of our minor crops, although at one time it gave promise of occupying an important place in agriculture. In 1888–89 the area under the crop was stated to be 6,641 acres, including 4,833 acres in New South Wales, 1, 685 acres in Victoria, and 123 acres in Queensland. This early expansion was, however, not sustained, and the following years, while exhibiting wide variations in acreage and production, showed generally a downward trend. In 1920–21 the total Commonwealth acreage was 1,345."

From the statistics furnished in the report it appears that in 1922–23 there was an area under tobacco of no less than 3,727 acres, with a corresponding production of leaf amounting to 32,729 cwts. ; by 1927–28, however, the figures had fallen to 2,133 acres and 16,143 cwts. respectively. These latter figures represent double the area and output of the year 1901–02 and in any contemplated development of the industry there is thus still a good basis on which to work.

The Committee make many interesting observations regarding the defects which require to be remedied, but are of opinion that Australian tobacco growers generally show intelligence and initiative. It is of interest to note that the percentage of Australian-grown leaf employed in the tobacco factories of the Commonwealth has declined from nearly 14 per cent. in 1915–16 to only slightly over 5 per cent. in 1928–29, but the Committee feel confident that if their recommendations are adopted it should be possible not only to provide increased revenue but to establish tobacco-growing on a firm basis, making it an enterprise which in time will add considerably to land settlement and provide a greater and more prosperous industry to the Commonwealth. They further consider that in the Commonwealth " there should be at least 10,000 white growers, the majority of whom should be capable of producing an ever-increasing proportion of high-grade bright leaf entirely suitable to the manufacturers and wholly acceptable to the smokers of Australia."

The Committee's principal recommendations are summarised as follows at the end of the report :

1. That no bounty be paid by the Federal Government on Australian-grown leaf.

2. That further protection be imposed by an alteration of the import and excise duties, preferably by the abolition of the excise on leaf used in manufacture in Australia, and the addition of an amount equivalent to the excise so abolished to the import duty on all classes of tobacco entering Australia.

3. That the Federal investigation work hitherto carried out with financial assistance from the British-Australasian Tobacco Company should be carried on by a Federal Tobacco Department, presided over by a Federal Director, who should be responsible only to a Minister, and who should be in charge of all research and experimental work, and all matters relating to the welfare of the tobacco growers. The British-Australasian Tobacco Company and any other manufacturing interests should be given every opportunity to make special monetary contributions to the funds used by the Department in research and experimental work.

4. That to assist the Director and give the growers a voice in the control of the industry, an Advisory Council be formed, consisting of two growers' representatives from each tobacco-producing State, the Directors of Agriculture in tobacco-producing States to be *ex officio* members ; the Federal Director to be Chairman of the Council, which should hold meetings at Canberra at least twice every year ; the Council to report in writing to the Minister after each meeting.

5. That the present Director, Mr. C. M. Slagg, should be appointed as Federal Director on a permanent basis, subject to salary and other conditions to be fixed by the Minister.

6. That the headquarters of the Federal Tobacco Department be established at Canberra.

Fire-Resisting Empire Woods.—From the point of view of fire risks, certain structures, including classes of doors, shutters, staircases, landings, beams and posts, verandahs and balustrades, are regarded as key components of buildings. To meet the requirements of the London Building Acts (Amendment) Act, 1905, these components, if constructed of timber, must be made from approved fire-resisting woods. Further, under the London County Council (General Powers) Act of 1909, dealing with "steel-frame" buildings, and under the London County Council regulations for 1901, dealing with theatres, all floors and staircases, if constructed of timber, must be of fire-resisting woods.

In the First Schedule of the above-mentioned (1905) Act, among hardwoods deemed to be fire-resisting, oak, teak, jarrah and karri are specifically quoted by name. All the timbers mentioned are of Empire origin, though oak and teak would include varieties not derived from Empire sources.

In the course of their enquiries regarding the development of the use of Empire woods in this country, the Imperial Institute Advisory Committee on Timbers considered that a number of hardwoods selected from those examined by them would be found to be markedly fire-resistant, and on this account valuable for the construction of buildings governed by the London Building Acts. At the same time, knowledge of the fact that the timbers were accepted by the London County Council as fire-resisting materials would lead to an extended demand for the timbers. Application was therefore made to the London County Council for a series of timbers selected by the Committee to be submitted to the official tests of the Council, with a view to the inclusion, in the First Schedule mentioned above, of such woods as were found, as a result of the tests, to be fire-resistant. The application was granted and the following timbers were finally approved as fire-resisting materials, namely :

Andaman Padauk (*Pterocarpus dalbergioides* Roxb.), from the Andamans.

Iroko, Odum or African Teak (*Chlorophora excelsa* Benth. and Hook.), from Nigeria and the Gold Coast.

African Walnut (*Lovoa Klaineana* Pierre ex Sprague), from Nigeria.

Mora (*Dimorphandra Mora* Benth. and Hook. = *Mora excelsa* Benth.), from British Guiana.

Crabwood (*Carapa guianensis* Aubl.), from British Guiana.

The following is a copy of the approved Recommendation of the Building Acts Committee governing the acceptance of the timbers, as reported in the Minutes of the Council dated July 22, 1930 :

"That the Council, in pursuance of the power vested in it by the First Schedule to the London Building Acts

(Amendment) Act, 1905, do approve padauk, iroko, odum, African walnut, mora and crabwood as *fire-resisting* for the like purposes for which hard timber may be used and under the conditions relating to the use of oak, teak, jarrah, karri and other hard timber set out in Part II of the said Schedule. (Agreed.)"

A further number of very useful decorative and structural timbers of Empire origin thus become available to architects and builders for the construction of essential parts of buildings. All the woods mentioned are referred to in an article on Empire Timbers for Decorative and Building Work published in the present issue of this BULLETIN (p. 41). Mora has hitherto been regarded as suitable mainly for heavy construction work, but it is well adapted for stair treads and other purposes where a durable, wear-resisting wood is required.

It may be mentioned that hand specimens of the recently approved timbers have been supplied to the Superintending Architect of the London County Council, and also, at his request, to forty-three District Surveyors of the Council, and to the Chief Officer of the London Fire Brigade. Steps are being taken to bring the facts to the notice of other persons interested, including architects, builders and the timber trade.

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NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

British Policy and Canada, 1774–1791. A Study in Eighteenth-century Trade Policy. By Gerald S. Graham, M.A., Ph.D. Pp. xi + 161, 8¾ × 5¾. (London: Longmans, Green & Co., Ltd., 1930.) Price 10s. 6*d.*

This work, forming the fourth volume in the series of "Imperial Studies" issued under the auspices of the Royal Empire Society, is (to quote the preface) "chiefly concerned with the development of trade policy in the new British Empire after the loss of the American Colonies." It is written in an attractive style and is copiously annotated, as well as supplemented by an excellent bibliography. The subject is one of interest mainly to Canadians and to students of British colonial history, and to these and other possible readers it may be recommended as an instructive treatise.

SIAM: NATURE AND INDUSTRY. Pp. 324, 9½ × 6½. (Bangkok: The Ministry of Commerce and Communications, 1930.)

In a foreword to this attractive volume, the Siamese Minister of Commerce and Communications states that " the aim has been to put together before the public, in a concise manner, some of the more important data available about the economic life and products of the kingdom of Siam. It is hoped that this book will fulfil the requirements of those who really wish to study the status and situation of Siam on the production side." The volume consists of self-contained chapters of great interest on the geography, vegetation, fauna, ethnology, forestry, mining, agriculture, industries, trade and commerce, railways, highways and so on; the various subjects being dealt with by individual writers specially qualified for their task. Numerous illustrations and statistical tables assist the reader to appreciate the great progress made by Siam in recent times, as an instance of which it may be mentioned that nearly 3,000 kilometres of railway are now open in the country. There seems to be no reason why this progress should not continue, although the extreme dependence of the country on rice cultivation, both for domestic purposes and for export, indicates the desirability of some additional staple crop as a safeguard against disaster.

CEYLON: NEW AND OLD. By St. Nihal Singh. Pp. 98, 9 × 8. (Colombo: Ceylon Government Railway.)

This is a well-written, popular account of the scenery, daily life and history of Ceylon, and should be of considerable interest and utility to tourists and others. The book is copiously illustrated with excellent and attractive photographs.

SOCIAL AND ECONOMIC GEOGRAPHY. By L. Brettle, M.A., B.Litt., F.R.G.S. Pp. xvii + 459, 8¼ × 5¾. (London: Sir Isaac Pitman & Sons, Ltd., 1931.) Price 10*s*. 6*d*.

This work is intended principally for students, especially those preparing for examinations in geography, particularly in connection with economics and commerce. The author describes it as " a synopsis in maps, pictures, statistics, diagrams and letterpress of social and economic geography based on the natural regions of the world."

It is a book likely to be of great value to those for whom it is intended, the subject being clearly and interestingly presented, and illustrated by a large and varied selection of maps, pictures and statistical tables. Most sections of the work are followed by a series of questions, exercises and topics for discussion, which should be useful for testing the progress of students.

LE COTONNIER. II. MÉTHODES CULTURALES, CULTURE ANNUELLE, CULTURE PERENNANTE, CULTURE PROPREMENT DITE. By Ray C. P. Boone. Pp. 428, 10 × 6½. (Paris : Société d'Éditions Géographiques, Maritimes et Coloniales, 1930.)

The first volume of this series, a notice of which was published in this BULLETIN (1929, **27**, 427), deals with the botanical classification of cottons and discusses such matters as varieties, heredity, hybridisation, selection and biotaxy.

The present volume is devoted mainly to problems concerned with the cultivation and harvesting of the crop. After discussing the relative advantages of growing the plant as an annual and as a perennial, consideration is given to the various factors involved in its cultivation. Information is provided regarding the climatic and soil requirements of the crop, the preparation of the land, selection and treatment of seed for sowing, and the various cultural operations entailed, including sowing, harrowing, ploughing, weeding, thinning out the plants, pruning, topping and irrigation. Attention is also given to the rotation of crops, manuring, harvesting and yields.

The book is copiously illustrated and contains an extensive bibliography.

DIETETICS IN WARM CLIMATES : INCLUDING FOODSTUFFS, THEIR ANALYSES AND RÔLE IN DISEASE. By J. Neil Leitch, M.D., B.S. (London), M.R.C.S. (England), L.R.C.P. (London), D.T.M.&H. (England), F.R.G.S., F.Z.S. Pp. 486, 9½ × 6. (London : Harrison & Sons, Ltd., 1930.) Price 25*s*.

The author of this useful work has spent some years as pathologist in the West African Medical Service, and prior to that gained first-hand experience of conditions in India. He is therefore able to write with intimate knowledge of the dietetic requirements of the tropics. At the same time he has not failed to draw on the widely scattered literature of the subject published by other workers.

The first three chapters of the book deal with the general principles of dietetics in the tropics. Then follows a survey of dietaries in actual use in all the warmer parts of the world, including the nature, quantities, chemical composition and food values of a very large number of diets. Much of the information contained in this section was obtained by Dr. Leitch in reply to a questionnaire addressed to the medical and sanitary services in the various countries and is thus of special value. Notes are given on the source, composition, uses, etc., of the various animal and vegetable food-stuffs employed in the tropics, the vegetable products being arranged under their natural orders ; the analyses and vitamin content of the food-stuffs are collected together in a series of tables. Other aspects of the subject dealt with are diseases associated with defective dietaries and food intoxications and poisoning.

In his last chapter, entitled " The Future," Dr. Leitch pleads for a more intensive study of dietetics in the tropics and suggests the formation of an international dietetic committee to this end. In his opinion at least half the inhabitants of the tropics owe their ill-health to inadequate or unbalanced dietaries.

MAIZE IN SOUTH AFRICA. By A. R. Saunders. Pp. 284, 8½ × 6½. (South Africa : Central News Agency, Ltd. ; London : Gordon & Gotch, Ltd., 1930.) Price 20*s.*

Though South Africa is generally regarded as an important maize-producing country, and maize is by far its principal cereal crop, the contribution made by the Union to the world's total production of the cereal is comparatively inconsiderable, and the yield per acre in the Union compares unfavourably with that in most of the principal maize-growing countries.

The last twenty years or so have seen a considerable increase in the quantity of maize produced in South Africa, but it is very desirable, especially in view of the growing consumption of the grain within the Union itself, that the output should become greater still, and it is through an improvement in the yield per acre rather than by any notable extension of the area under maize in the Union that this seems likely to be realised. The author of this book, who is on the staff of the Union Department of Agriculture, has no doubt that it could be effected by better farming, though there are limiting factors of soil and climate, among which the most important is the insufficiency of the rainfall for the attainment of yields approaching those reached, for instance, in the United

States and Argentina. The present volume should prove a useful guide to all who are concerned with making the best of maize-growing, either in South Africa or elsewhere.

The opening chapters deal with the history and origin of maize and its world production, with particular consideration of its cultivation in the different areas of South Africa. It is a pity that the statistics in Chapter I do not relate to years later than 1925, particularly as the South African maize crop in 1924–25 was quite exceptionally high, as indeed appears from a table in Chapter XIII, where the statistics of production have been brought up to 1926–27. The use of the earlier year in the table, on page 20, of maize production in various countries renders the comparison between South Africa and other countries misleading.

The chapters dealing with the various biological and agricultural aspects of maize-growing, such as the botany of the plant, soil fertilisation and crop rotation, diseases and insect pests, etc., are written on lines that bring out clearly the scientific principles involved and explain their application or significance in relation to maize. In particular, the chapter on genetics may be read as an excellent introduction to the general study of its subject, the maize plant (which is " classical " in this connection) being used as a means of illustrating Mendelian factors and the practical application of the laws governing them to breeding and seed selection. Even the chapter on " Classification and Varieties" is something more than a descriptive catalogue, as it explains the significance of varieties and types and the particular complications and difficulties of such classification in the case of the maize plant. Finally there are useful chapters dealing with the uses of maize and its position in commerce.

The book can well be recommended to all who are concerned with the production of maize on other than " rule of thumb " methods, and should be of considerable help to any who may have lacked the opportunity for that preliminary study of " pure " agriculture which is so desirable for all engaged in any form of crop raising. It is likely also to appeal to people whose interest in crop production and its scientific basis is not limited to maize.

The Culture of the Orange and Allied Fruits. By H. Clark Powell. Pp. 355, 8½ × 5½. (South Africa: Central News Agency, Ltd.; London: Gordon & Gotch, Ltd., 1930.) Price 21s.

In 1927 the Empire Marketing Board arranged for Professor H. Clark Powell to visit and report on the actual or potential citrus-producing countries of the Empire. As the result of the experience gained on this tour, combined with his previous intimate knowledge of the industry in the United States of America and South Africa, Professor Powell is well equipped for the task attempted in this volume.

Full particulars are given of all phases of the cultivation, preparation for the market and commercial handling of the various citrus fruits, with special reference to South African conditions. The general usefulness of the work is increased by pointing out how practices suited to South Africa can be modified for different conditions elsewhere and by discussing, on broad lines, bud selection, tree records, use of fertilisers, marketing organisations, etc., which are subjects of common interest in all citrus-growing countries. In addition, separate chapters are devoted to the West Indies, Palestine, Cyprus, Florida and California.

For the improvement of the South African industry Professor Powell stresses two desiderata : (1) improvement in cultural methods, including the selection and propagation of high-bearing trees, so as to increase the yields per acre ; and (2) greater development of co-ordinated marketing. As an instance of the degree to which the latter may be successfully carried, the author cites California, whence " about three-quarters of the fruit to the United Kingdom is shipped under the one brand ' Sunkist,' the distribution of which is in the hands of a single individual." A valuable feature of the book is the attention devoted throughout to economic considerations. Professor Powell has kept steadily in view the needs of the person or community desiring not merely to cultivate citrus trees, but to develop a citrus industry, and to all who have this for their goal the book should be very valuable.

BABASSU. Instituto de Expansão Commercial, Ministerio da Agricultura, Industria e Commercio, Brasil. Pp. 70, 10¾ × 7¼. (Rio de Janeiro, 1930.)

This monograph, which is written in Portuguese and English in parallel columns, is presumably designed to show the vast potentialities of the Babassu nut. The Babassu palm flourishes in Brazil from Amazonas to Bahia and Minas Geraes, and it is estimated that there are at least 1,000,000,000 of the trees in that country, of which the greater number are found in Piauhy and Maranhao. Although all parts of the palm are utilised, the product of the greatest value is the nut. Details are given of the composition of the kernels, oil and oil-cake. The well-known uses of the oil are described, and in this connection attention is drawn to its potential utilisation for driving internal combustion engines of the Diesel and semi-Diesel types. There are stated to be sixteen factories in Brazil where Babassu oil is prepared, but only two of them, one in Maranhao and the other in Para, are equipped with modern plant. The value of the destructive distillation products of the shells is pointed out, and particular stress is placed upon the suitability of the resulting charcoal for use in smelting iron ore. Reference is made to machines for cracking the nuts, of which there are some six different types in use. Details are supplied of the profit to be derived from exploiting the palms, and notes are given relating to concessions and to the cost of purchasing or renting land. Statistical data show that most of the kernels exported go to Germany; Holland, Denmark, Belgium and the United Kingdom follow in order of importance. The monograph is well illustrated with photographs, statistical diagrams and maps.

THE WOAD PLANT AND ITS DYE. By the late Jamieson B. Hurry, M.A., M.D. Pp. xxv + 328, 8¾ × 5¾. (London: Humphrey Milford, Oxford University Press, 1930.) Price 21*s*.

Dr. Hurry's book, which appears posthumously under the supervision of Mr. A. R. Horwood, will no doubt remain the standard work of reference in English concerning the once so important but now virtually extinct woad dye industry. As is well known, blue woad dye, which was the forerunner in Europe of the Eastern natural indigo, was obtained from the leaves of the cruciferous plant *Isatis tinctoria* L. This plant is a biennial and the dye was prepared from the basal leaves picked during the first year. The leaves were comminuted by heavy rollers and the resulting pulp was kneaded into balls which were air-dried in sheds. The balls were then reduced to powder which was moistened and allowed to ferment for several weeks, resulting in the formation of the dark, clay-like woad used in the dye vat. The liquid in the latter was prepared by heating a solution of the woad with a mordant (usually alum or potash), during which process a further fermentation took place. The fabrics were dyed blue in the vat, but the colour was intensified by oxidation on exposure to the air. The production of the blue colouring matter is analogous to that of indigo (*Indigofera*). A colourless glucoside (isotan) is converted into the blue pigment by the combined action of a specific enzyme and subsequent oxidation of the resulting product.

Woad was the fashionable colour for clothing during the Middle Ages and formed an important commodity not only in local industries, but in international commerce. The plant was extensively cultivated on the continent of Europe, notably in Germany, France and Italy, and to a much less extent in England, and was the basis of one of the most important agricultural industries of the times. The quantity of dye produced in this country (chiefly in Somerset and Lincolnshire) was much less than the requirements, and large supplies were annually imported from Europe. The primary factor in the steady and inevitable decline in the use of woad was the discovery in 1560 of the new route to India, via the Cape, which resulted in the introduction of Indian indigo into Europe at prices which ultimately led to the ousting of the European product. As early as 1563 the Eastern dye was being regularly imported, and, in spite of drastic legislation, the use of woad rapidly declined. The industry, however, lingered for many generations ; the last crop of woad in Germany appears to have been gathered in 1865, and in 1887 the industry ceased in France. It is remarkable that the cultivation in this country survived at the date of writing the present book, though Mr. Horwood states that at the time of going to press the two last surviving British woad farms (in East Anglia) were in danger of being discontinued. The woad produced on these farms, however, has not been employed as a blue dye, but as an adjunct in the " indigo-woad vat " in which natural or artificial indigo is used for dyeing fabrics. The woad assists the fermentation process which converts the insoluble blue indigotin into indigo-white, in which the fabrics are immersed and later exposed to the air to bring about the formation of indigo-blue by oxidation. The woad used for this purpose, in fact, contains no dye, this having been destroyed by bacterial action during its preparation.

The author covers the whole subject of the woad industry. The plant and its cultivation are fully described. Special reference is made to the important part played by woad cultivation in improving agricultural methods in Europe, since the woad crop required the most careful preparation of the soil and subsequent treatment ; this led to the adoption of improved methods for other crops.

The accounts of the industries in Germany, France, Italy and England are of great interest, as is also the description of the manufacture of the woad. The economics of the industry are dealt with in chapters relating to the trade routes of the product, its protection by legislation, the taxation of the dye, its relation to agriculture and as a source of national wealth. The book is illustrated by a number of very interesting drawings and photographs.

THE MARKETING OF WOOL. By A. F. du Plessis, M.A. Pp. xiii + 337, 8½ × 5½. (London: Sir Isaac Pitman & Sons, Ltd., 1931.) Price 12*s*. 6*d*.

Among the world's most important commercial products, wool is one of those whose marketing is least understood by those not actually concerned with it. This book claims to be the first serious attempt to examine the mechanism of wool distribution, and it can well be recommended as giving in considerable detail the information required for a proper understanding of the subject. As a preliminary to the discussion of marketing itself, an interesting account is given of the production of wool in the chief countries of the world, the various processes in the manufacture of wool and its preparation for the market. Subsequent chapters deal with standardisation, sale by private treaty, public auctions, co-operative marketing, control in the marketing of wool, establishment of wool exchanges on the lines of existing cotton exchanges, statistics and market information, short-term credits and the question of prices.

PLANTS OF THE GOLD COAST. By F. R. Irvine, D.Sc., F.L.S. Pp. lxxix + 521, 7¾ × 5. (London: Humphrey Milford, 1930.) Price 5*s*.

Dr. Irvine, who is on the staff of the Achimota College, states that " this work has been undertaken mainly to help African teachers and other Africans, particularly students, who are willing to take a scientific interest in the rich flora of their country. It is also hoped that it will be of value to European officers and others."

In the introductory chapter the author indicates the wide knowledge of plants and their properties which is possessed by the native population of the Gold Coast. Here, as elsewhere, primitive man has proved himself a keen observer, as evidenced by the fact that he has, unaided, discovered the value of the more important plants useful as foods, drugs, stimulants, fish poisons, etc. An excellent summary follows of the general ecology of the region, the characteristics of the evergreen, deciduous, savannah, fringing and secondary forests, of the various types of grassland, and of the strand and mangrove associations being briefly described and well illustrated.

The main part of the book consists of a list of some 1,200 plants, arranged alphabetically under their generic names, with a brief description of each, its occurrence, uses and native names. Cross reference is facilitated by lists of the plants grouped according to their uses. The large variety of languages and dialects current in the Gold Coast necessitates some 75 pages being devoted to indexes.

A feature of the book is the large number of excellent full-plate and other illustrations, both of types of vegetation and of individual plants. This could not be anticipated in a book published at the low price of 5*s*., and would not have been possible without the assistance of the Gold Coast Government, for which the author expresses his thanks.

The Plasticity of the Root System of Corsican Pine in Early Life. By R. N. Aldrich-Blake, M.A. Oxford Forestry Memoirs, Number 12, 1930. Pp. 63, 10¾ × 7½. (Oxford: The Clarendon Press, 1930.) Price 6*s*.

The Corsican pine (*Pinus laricio*) gives promise of being a valuable timber tree in Great Britain provided the serious difficulty of establishing plantations of it can be overcome. Direct sowing is seldom successful, and heavy losses are sustained both in nurseries, when the seedlings are lined out, and again when they are transplanted to permanent places in the forest. These troubles are due to the fact that the Corsican pine, which is a drought-resistant tree, early forms a deep main root, very sparsely branched, so that the young plants are very intolerant of being moved.

This memoir records the results of investigations made in the attempt to overcome this difficulty. These include observations of the seasonal variations in water in the plants and of the anatomy and morphology of their root systems, and experiments on defoliation and root pruning and the growth of seedlings in humus and in sand cultures. No definite recommendations for the forester can yet be made, as, although many interesting results have been obtained, the author states "it is clear that Corsican pine seedlings exhibit a high degree of plasticity in their root development, but the modifications induced by all treatments save root pruning *in situ* are the reverse of those desired for practical ends."

GRUNDRISS DER TROPISCHEN UND SUBTROPISCHEN BODENKUNDE. By Dr. P. Vageler. Pp. 217, 8 × 6. (Berlin : Verlagsgesellschaft für Ackerbau, m.b.H., 1930.) Price R.M. 12.75.

The scientific study of soils has, in recent years, made remarkable advances, and this book gives a lucid account of the present state of knowledge of the subject, with especial reference to tropical and subtropical conditions. A great handicap to progress in tropical soil science has been the fact that much of the pioneer work on the soil was done in temperate countries, such as Great Britain and Germany, and indiscriminate attempts have frequently been made to apply results obtained under such conditions to tropical countries. It is now recognised, however, that the entirely different environmental factors met with in the tropics are bound to make such attempts abortive and the whole study of tropical soil problems is being placed on a sounder basis.

The present book opens with a discussion of the theoretical and practical problems met with in tropical soil science. The speeding up of all chemical and physical processes in the soil owing to the higher temperatures prevalent is particularly emphasised.

The second section, which is one of the most important in the book, deals with the various rocks and mineralogical species which form the raw material for soil formation and which are also now beginning to be used as an additional means of soil classification. The author gives an account of methods for the mineralogical examination of soil fractions in any soil.

The method of the International Society of Soil Science, for the preliminary treatment of the soil for dispersion in mechanical analysis, is quoted for the separation of the coarse sand and fine sand fractions, the finer fractions, namely silt and clay, consisting of particles too small for mineralogical examination. It seems highly probable, however, in view of very recent work carried out at Bangor by Professor G. W. Robinson and his assistants, that the International Society's method may profitably be modified by the substitution of soda for ammonia in the dispersion. The further separation of the sand fractions into smaller groups by treatment with various heavy liquids is detailed and the examination of these groups to determine the mineralogical species which they include is well described. The mineralogical species regarded as important in the soil are classified as follows : quartz, volcanic glasses, felspars and felspar derivatives, micas, amphibole and pyroxene, lime minerals, phosphatic minerals, primary iron and titanium minerals and the secondary minerals. Each of these groups is dealt with separately and the distinguishing characteristics of each species given. This classification is also well summarised in a table at the end of the book.

This long section is followed by two shorter ones dealing with the most important rocks involved in soil formation and with secondary rock formation, for example by the building up of " hard pan," in the soil itself.

In the third chapter of the book are considered the various types of tropical vegetation, differing according to their geographical position, and the influence of these different types as the source of the organic matter in the soil. Climatic factors, such as rainfall and average temperature, as agents of soil formation and their effect on the surface character of the soil and on the vegetation are next dealt with at some length.

The origin of tropical and subtropical soils is considered under a number of headings. The various agencies, physical, chemical and biological, which cause weathering of rocks, and their effects on different parent materials, are discussed, together with the transformation of organic residues in the soil into humus and the influence of this humus in the chemical weathering of rocks. The transference of soil material by various agencies such as wind and water and its importance in soil formation are pointed out.

In the next three sections, dealing with the soils of the permanently wet, the intermittently wet and the dry regions, the author describes the main soil types of the tropics and subtropics. The types are based chiefly on examination of the soil profile, and the characteristics of the profile and the chief horizons present are given for each typical case.

The three final sections of the book give an excellent résumé of the chief factors to be considered in the choice of suitable soils and crops in tropical agriculture. The various factors, such as economic considerations with regard to markets when the crop is grown as well as the chemical and physical characters of the soil, are well set out. This section includes a number of useful statistics, such as optimum rainfall for various crops and the optimum and limiting pH values of the soil suitable for some important tropical plants.

The book is illustrated by a number of diagrams and photogravure plates, and is well indexed. It has a few minor points open to criticism. For example, there are only occasional references to current literature, and then solely by the name of the author. In the case of the more important authors, such as Glinka or Waksman, who have published much work, this name-reference is of little or no value to the student desiring to consult any particular paper. The bibliography, also, at the end of the book gives a bald list of titles and authors' names, without even the date or place of publication.

These, however, are small matters, and the book as a whole forms an excellent general introduction to the study of tropical and subtropical soils.

Introductory Economic Geology. By W. A. Tarr, Ph.D., Sc.D. Pp. ix + 664, $9 \times 5\frac{3}{4}$. (London: McGraw-Hill Publishing Co., Ltd., 1930.) Price 25*s*.

This is a very useful introductory work on economic geology. It is written by an American mainly for Americans, and the deposits described have naturally been selected from those occurring in the United States.

Each metal or mineral is treated separately, the deposits in the United States being first described with brief references to foreign deposits; then follow uses, production and a selected bibliography. In certain instances, of course, where the metal happens to be scarce or little worked in the United States, the author has had to fall back on foreign deposits for his descriptions, notably as regards antimony, chromium, cobalt, manganese, nickel, platinum, tantalum, tin, tungsten and vanadium.

Of special interest are the descriptions of the gold and silver deposits, the base-metal deposits, and the coal, petroleum and natural-gas deposits of the United States.

A number of useful maps show the world deposits of the various metals and minerals.

There are important chapters on structural materials, on materials used chemically and on materials of miscellaneous use, including abrasives, bentonite, diaspore, diatomaceous earth, felspar, fuller's earth, gems and semi-precious stones, graphite, mica, mineral fillers, pyrophyllite, quartz, refractories, meerschaum, talc and tripoli.

Professor Tarr's work should prove of considerable interest and value to British students, more especially for the descriptions and illustrations of the many highly important mineral deposits of the United States, which are usually only to be found by reference to numerous technical publications.

Like all the McGraw-Hill Publishing Co.'s books, the work is well printed and illustrated, having no less than 249 figures in the text.

GUIDE TO THE STUDY OF NON-METALLIC MINERAL PRODUCTS (EXCEPT BUILDING STONES). By W. S. Bayley. Pp. xvi + 530, 8½ × 5½. (New York: Henry Holt & Co., Inc., 1930.) Price $4.00.

Professor Bayley's work has been written to furnish a basis for a one-semester course in the study of the origin and occurrence of the more important non-metallic mineral substances employed in the industries.

Very interesting and informative are the portions of the book relating to underground water, including the ground water, shallow wells, springs and artesian wells (30 pages), petroleum, natural gas and bitumens (over 100 pages), coal (50 pages) and salines and salt (30 pages).

Some of the statements in the text are not quite correct. China clay is classed with paper clay as a white, fine-grained plastic sedimentary clay that is uniform in texture. Although China clay is often of sedimentary origin, the most important China clay or kaolin deposits of the world, namely those of Cornwall, are undoubtedly of residual origin.

Mexican onyx is described as a calcite stalactite, but it may be pointed out that, although it sometimes appears in stalactitic or stalagmitic forms, it usually occurs in more or less thick and extensive beds in the states of Puebla and Oaxaca, and in the Territory of Lower California, Mexico. The onyx marble is quarried out into blocks, which are exported for ornamental and building purposes. The more important deposits of Mexican onyx have been deposited around saline springs, and they are considered to be genetically related to such springs.

Emeralds in Colombia are said to occur in pegmatite-like veins in a clay-slate. As a matter of fact, the emeralds of the well-known Muzo mine of Colombia are found in calcite veins traversing black carbonaceous limestones and shales of Lower Cretaceous age.

Notwithstanding a few blemishes of this kind, the work should prove a most useful one to students as a guide or introduction to the study of non-metallic minerals and their products.

LIMESTONES. THEIR ORIGINS, DISTRIBUTION, AND USES. By F. J. North, D.Sc., F.G.S. Pp. xxiii + 467, 8½ × 5½. (London: Thomas Murby & Co.; New York: D. Van Nostrand Co., 1930.) Price 16*s*.

This book aims at summarising in a convenient form the whole subject of the formation, occurrence, characteristics and utilisation of limestone.

It is presented in three sections. The first is a short account of the nature, origin and varieties of limestone; the second and longest section, which occupies more than half of the book, deals with the distribution of limestone in the British Isles, while the third section is devoted to the effect of limestone upon scenery and water-supply, and its uses in agriculture and other industries.

In the section on distribution, limestones are classified according to their geological age. This section is very complete and contains a considerable amount of purely stratigraphical geology, including diagrams illustrating the supposed distribution of land and sea during past geological epochs.

The book is unusually wide in scope, profusely and well illustrated, and so well written as to be interesting even to the non-technical reader.

OUTLINES OF PHYSICAL GEOLOGY. By Chester R. Longwell. Pp. v + 376, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1930.) Price 15*s*.

This excellent introductory textbook of physical geology has been prepared from the third and revised edition of Part I of the well-known *Textbook of Geology* by the late Louis V. Pirsson and Charles Schuchert. The present text is somewhat more elementary and briefer than the original, all chapters, with the exception of Chapter I, having been shortened, while three chapters entitled "The Interior of the Earth," "Land Forms" and "Ore Deposits" have been omitted.

The work is exceptionally well illustrated and should prove of considerable value to students.

THE MINERAL INDUSTRY OF THE FAR EAST. By Boris P. Torgasheff. Pp. 510, 9½ × 6½. (Shanghai: Chali Company, Ltd., 1930.) Price 40*s*.

From a statistical point of view this work is invaluable, as the author has had access to data and other information relating to several countries of the Far East, the official returns of which are always more or less incomplete.

A useful table shows the Far Eastern output of mineral products as compared with the world's production. It will be seen from this table that the output of antimony and tungsten predominates in the Far East, forming 86·8 and 61·8 per cent. respectively of the world's total. Talc and kaolin come next, with 29·9 and 29·4 per cent. respectively. The production of arsenic, graphite, edible salt, magnesite and pyrite is also important, ranging from 16·2 per cent. in the case of arsenic down to 11·1 per cent. in that of pyrite.

It would appear that the work has been a long time in preparation, and, unfortunately, some of the data and statements contained in it have not been brought up to date. The Imperial Institute Statistical Summaries from 1923 to 1925, inclusive, are frequently quoted in the text, but, as the work was not published until 1930, it seems a pity that the Statistical Summaries from 1926 to 1928 were not included, as they must have been available by then. On page 300 it is stated that half the world's output of graphite is used for making crucibles. This was true in pre-war days, but since then the percentage used for that purpose has dropped to 10, or at most 13, of the world's output.

The reference to cobalt in the Belgian Congo is also out-of-date. The greater part of the cobalt in the ores of that country is no longer lost, as stated, for the ore is now being smelted locally to form a cobalt-copper-iron alloy, which is shipped to Belgium, where it is reduced to metal.

Again, the author says that the recently discovered Transvaal deposits of platinum have as yet given no noticeable results. The production of platinum metals from these deposits commenced in 1926, with 8,723 oz. In 1927 it amounted to nearly 13,000 oz., and in 1929 to upwards of 24,000 oz., which, in that year, was equal to about half the Colombian exports of platinum, and to nearly 25 per cent. of the Russian output, which is surely a noticeable result.

The Far Eastern output of gold only amounts at present to 8·9 per cent. of the world's production, but the author tells us that, according to the estimates of experts, the Russian Far East deposits, if worked on modern methods, could produce as much gold per annum as the Transvaal.

It is said that Indo-China is capable of furnishing from 15,000 to 20,000 metric tons per annum of graphite of a good-grade.

The actual output of natural soda in the Far East hardly covers one-fifth of the consumption in those countries, but it is stated that there are considerable reserves of this mineral in North Manchuria, China proper and Zabaikalia.

Of interest is the reference to the rich reserves of bauxite and diaspore in North Manchuria, some of the deposits of which are favourably situated as regards water power. It seems that an aluminium plant will be or has been erected in Japan, which will utilise the bauxite of that country, as well as the Chinese deposits in the region of Fuchow, Kwantung Province and, possibly, the North Manchurian deposits.

This unique work should find a place in every technical library, and be on the bookshelf of mining engineers and others interested in the mineral development of the Far East.

THE METALLURGY OF THE NON-FERROUS METALS. By William Gowland, F.R.S., A.R.S.M. Fourth Edition. Thoroughly revised by C. O. Bannister, M.Eng., A.R.S.M., F.I.C. Pp. xxxii + 633, 8¾ × 6. (London: Charles Griffin & Co., Ltd., 1930.) Price 30*s*.

Professor Bannister is to be heartily congratulated on this, the latest edition, of the late William Gowland's well-known work on the metallurgy of the non-ferrous metals.

Among the more important alterations and additions in the fourth edition may be mentioned: a summary of the properties of silica at different temperatures (page 3), the effects of foreign elements on the properties of copper (pages 56–61) and an account of the extraction of cadmium by wet methods (page 510). The portions relating to the metallurgy of platinum and aluminium have been largely rewritten and brought up-to-date.

In a textbook, written mainly for students, it is somewhat difficult to keep the matter quite up-to-date, without unduly enlarging the size of the volume, but brief references might have been given to the important Tainton electrolytic zinc process and to the Harris process of refining lead.

There is only a very brief reference to vertical retorts used in the distillation of zinc ores, but they undoubtedly have a great future, and the New Jersey Zinc Co., U.S.A., is now successfully using vertical carborundum brick retorts for treating complex oxidised ores of zinc.

In the Betts process of electrolytic refining of lead, the wooden vats, coated with asphalt, mentioned in the text, have been almost entirely superseded by concrete cells.

The work is illustrated by 5 folding plates and 217 figures in the text, several of which are new.

Bannister's edition of Gowland contains a fund of information on the non-ferrous metals, which is, on the whole, up-to-date, and it can be recommended, not only to students, but to all interested in the metals treated of.

MINES AND MINING LAWS OF BRITISH COLUMBIA. By Arthur Fleming Crowe. Pp. viii + 386, 9 × 6. (Calgary: Burroughs & Co., Ltd., 1930.) Price $6.00.

This book has been carefully prepared to meet the requirements of the general mining fraternity for a clearly expressed statement of all metalliferous mining provisions relating to British Columbia.

The book is divided into eight parts, dealing respectively with: (1) general rights and obligations; (2) lode (mineral) claims; (3) placer claims and leases; (4) general mineral and placer acts provisions; (5) mining acts, other than mineral and placer acts; (6) mining companies; (7) taxation of mineral claims, mines and mining; (8) miscellaneous provisions, such as water rights, offences as to mines and mining under the Criminal Code of Canada, etc.

The work is authoritative and well written, and should prove valuable not only to the metalliferous mining industry of British Columbia as a whole, but also to the legal profession.

MARKETS OF LONDON. By Cuthbert Maughan. Pp. x + 208, 8½ × 5½. (London: Sir Isaac Pitman & Sons, Ltd., 1931.) Price 6*s*.

This book is based on a series of articles that have appeared in the *Times Trade and Engineering Supplement*. The author has a considerable inside knowledge of the City of London, and he has secured the assistance, where necessary, of others more intimately acquainted with the particular markets, with the result that his accounts of the different markets may be regarded as authoritative.

A book of this small compass, containing fifty-eight chapters, each dealing with a different market, naturally cannot give detailed information as to practice and procedure. Nevertheless, it admirably carries out its expressed intention of giving an idea of the way in which business is conducted in the various markets and in connection with the different commodities.

THE CONDENSED CHEMICAL DICTIONARY. Compiled and edited by the Editorial Staff of the Chemical Engineering Catalog. Second Edition, completely revised and enlarged. Pp. 551, 9 × 6. (New York: The Chemical Catalog Company, Inc., 1930.) Price $10.00.

This work of reference is intended primarily for business men and others without specifically scientific training, who may require information in an easily accessible form unencumbered with unnecessary technicalities. At the same time it appears from the success of the first edition that the book has proved acceptable to chemists and other technologists, and in the present edition an endeavour has been made to extend its usefulness to such people in connection with matters relating to products outside the particular spheres in which they are specialists. Its value in the technical laboratory and office is increased by the inclusion in an appendix of a number of tables of various constants, ranging from weights and measures to thermal resistivities.

BOOKS RECEIVED

The South and East African Year Book and Guide for 1931. Edited for the Union Castle Mail Steamship Company, Ltd., by A. Samler Brown, F.R.Met.S., and G. Gordon Brown, F.R.G.S. Pp. lv + 915, 7 × 4¾. (London: Sampson Low, Marston & Co., Ltd.) Price 2*s*. 6*d*.

South African Grasses. By E. P. Phillips, M.A., D.Sc., F.R.S.(S. Afr.). Pp. 224, 8½ × 5½. (South Africa: Central News Agency, Ltd.; London: Gordon & Gotch, Ltd., 1931.) Price 25*s*.

M. Pidance's Report on Lac-refining. Authorised translation by S. Mahdihassan. Pp. 10, 13 × 9½. (Hyderabad: The Osmania University Press, 1930.)

Life Movements in Plants. Edited by Sir Jagadis Chunder Bose, M.A., D.Sc., LL.D., F.R.S., C.S.I., C.I.E. Pp. vi + 211, 8¾ × 5½. (London: Longmans, Green & Co., Ltd., 1931.) Price 18*s*.

Handbuch der Pflanzenernährung und Düngerlehre. Zweiter Band. Düngemittel und Düngung. By Dr. F. Honcamp. Pp. xii + 919, 10 × 6¾. (Berlin: Verlagsbuchhandlung Julius Springer, 1931.) Price RM.86.

Phosphates and Superphosphates. By A. N. Gray. Pp. 275, 7¼ × 5. (London: International Superphosphate Manufacturers' Association, 1930.) Price 8*s*.

Minerals in Modern Industry. By Walter H. Voskuil, Ph.D. Pp. ix + 350, 9 × 5¾. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1930.) Price 18*s*. 6*d*.

ELEMENTS OF ENGINEERING GEOLOGY. By H. Ries, Ph.D., and Thomas L. Watson, Ph.D. Pp. vii + 411, 9 × 5¾. Second edition. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1930.) Price 18*s*. 6*d*.

THE CHEMICAL ANALYSIS OF ROCKS. By Henry S. Washington, Ph.D. Pp. xvi + 296, 9 × 6. Fourth Edition, Rewritten and Enlarged. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1930.) Price 20*s*.

THE JAPANESE EARTHQUAKE OF 1923. By Charles Davison, Sc.D., F.G.S. Pp. xii + 127, 8½ × 5½. (London: Thomas Murby & Co., 1931.) Price 7*s*. 6*d*.

DIZIONARIO DI MERCEOLOGIA E DI CHIMICA APPLICATA. By Professor Dr. G. Vittorio Villavecchia, in collaboration with Professors Dr. G. Fabris, Dr. G. Rossi and Dr. R. Belasio. Fifth edition. Volume III. (Naftalina—Sena). Pp. 522, 10 × 7. (Milan: Ulrico Hoepli, 1931.) Price L.60.

BULLETIN OF THE IMPERIAL INSTITUTE

A RECORD OF PROGRESS RELATING TO
AGRICULTURAL, MINERAL AND OTHER
INDUSTRIES, WITH SPECIAL REFERENCE TO
THE UTILISATION OF THE RAW MATERIALS
OF THE DOMINIONS, COLONIES AND INDIA

VOL. XXIX. NO. 2
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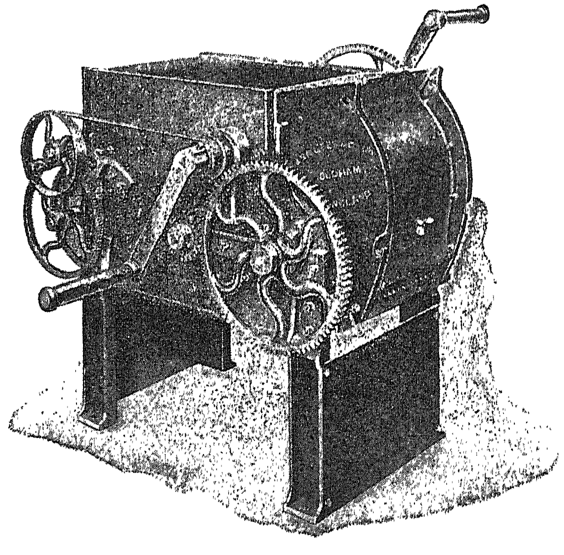

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REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

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DANTA TIMBER FROM THE GOLD COAST

The timber which is the subject of this report was forwarded to the Imperial Institute by the Conservator of Forests, Gold Coast, in March 1927.

The timber was sent in connection with an enquiry received at the Imperial Institute from manufacturers in the United Kingdom as to the possibility of using Empire woods for the handles of pick-axes and shovels in place of American hickory and ash. Some years ago specimens of hammer and pick handles made in the Gold Coast from Danta wood were supplied to the Institute by the Ashanti Goldfields Corporation, and it appeared that this timber would be worth detailed investigation in order to determine its suitability for use in this country. Application was therefore made to the Conservator of Forests in the Colony, who forwarded three logs, cut from a single tree, for examination.

Botanical specimens furnished by the Conservator were identified at Kew as *Cistanthera papaverifera* A. Chev.

The three logs (D.1, D.2 and D.3) received were each 13 ft. long and respectively 19, 21 and 23 in. in diameter. The timber was in sound condition, but some heartshakes had occurred. The heartwood was reddish-brown; the sapwood was pinkish-yellow and about 1 in. wide. The texture was fine and fairly dense and the surface lustrous. In the radial section a conspicuous feature was the ribbony effect due to the pronounced alternating spiral grain.

The timber was examined in both the green condition and air-dried.

Results of Tests on Green Timber

In view of the special purpose for which the timber was required, it was essential that the mechanical examination should include impact bending tests, and arrangements were accordingly made for such tests to be carried out at the Forest Products Research Laboratory, Princes Risborough. The centre log D.2 (bolts E, F, G) was sent to Princes Risborough for the purpose, and in addition a number of sticks, cut from logs D.1 and D.3 (bolts B, C, D and H, K, L respectively), were also supplied for impact tests.

The two logs D.1 and D.3 were utilised for the other standard tests at the Imperial Institute and similar tests were also made at Princes Risborough on log D.2.

The results of the whole of these tests on the timber in the green condition are summarised in the following table.

Summary of Tests on Green Timber

Static Bending :			
Moisture		*per cent.*	77·5
Specific gravity			0·616[1]
Maximum calculated longitudinal shear		*lb./sq. in.*	427
Fibre stress at limit of proportionality		*lb./sq. in.*	6,370
Fibre stress at maximum load		*lb./sq. in.*	11,800
Modulus of elasticity		*lb./sq. in.*	1,470,000
Work to limit of proportionality		*in.-lb./cu. in.*	1·48
Work to maximum load		*in.-lb./cu. in.*	11·5
Total work		*in.-lb./cu. in.*	38·9
Compression Parallel to Grain :			
Moisture		*per cent.*	75·6
Specific gravity			0·613[1]
Fibre stress at limit of proportionality		*lb./sq. in.*	3,650
Fibre stress at maximum load		*lb./sq. in.*	6,120
Modulus of elasticity		*lb./sq. in.*	1,637,000
Compression Perpendicular to the Grain :			
Moisture		*per cent.*	82·0
Specific gravity			0·632[1]
Fibre stress at limit of proportionality		*lb./sq. in.*	1,220
Hardness :			
Moisture		*per cent.*	76·5
Specific gravity			0·634[1]
Load per impression, lb.	Radial		1,530
	Tangential		1,590
	End		1,330

Impact Bending (100-lb. Hammer) :			
Moisture		*per cent.*	79·8
Specific gravity			0·593 [1]
Fibre stress at limit of proportionality		*lb./sq. in.*	14,150
Modulus of elasticity		*lb./sq. in.*	1,964,000
Work to limit of proportionality		*in.-lb./cu. in.*	5·76
Drop causing complete failure		*in.*	31
Shear :			
Moisture		*per cent.*	83·2
Shearing strength (lb./sq. in.)	Radial		1,540
	Tangential		1,414
Cleavage :			
Moisture		*per cent.*	82·4
Splitting strength (lb./in. width)	Radial		545
	Tangential		593
Tension Perpendicular to the Grain :			
Moisture		*per cent.*	80·8
Tensile strength (lb./sq. in.)	Radial		1,162
	Tangential		1,208
Shrinkage (Volumetric) :			
Moisture		*per cent.*	74·5
Specific gravity			0·712 [2]
Volume shrinkage		*per cent.*	14·3 [3]
Shrinkage (Linear) :			
Moisture		*per cent.*	64·6
Shrinkage (radial)		*per cent.*	6·3 [4]
Moisture		*per cent.*	71·0
Shrinkage (tangential)		*per cent.*	7·0 [4]

[1] *Based on dry weight and volume as tested.*

[2] *Based on dry weight and dry volume.*

[3] *Based on volume at given moisture content.*

[4] *Based on width at given moisture content.*

The green timber had an average weight of 69 lb. per cubic foot at 78 per cent. moisture content ; it was fairly hard and tough, strong, shock-resisting and of moderate stiffness.

Danta compares favourably with timbers ordinarily used in the manufacture of tool handles, such as hickories and ashes from the United States and the Indian timbers, Yon (*Anogeissus acuminata*) and Axle wood (*Anogeissus latifolia*), which are employed in India for the purpose. The table on page 118 gives the average strengths of these various species as determined by standard tests on the green timber. The figures show that Danta is slightly stronger, harder and tougher than the American species

STRENGTH VALUES OF GREEN TIMBER

Species.	Moisture content.	Weight (green).	Static Bending Strength.		Crushing Strength.		Shock-resisting Ability.		Stiffness.	Compression Perpendicular to Grain. Hardness.				Toughness.
			Fibre Stress.		Fibre Stress.		Work to maximum load (static bending).	Height of Drop[1] (impact bending).	Modulus of Elasticity (static bending).	Fibre Stress at limit of proportionality.	Load per impression.			Work to limit of proportionality in static bending.
			At limit of proportionality.	At maximum load.	At limit of proportionality.	At maximum load.					Radial.	Tangential.	End.	
	Per cent.	*lb./cu. ft.*	*lb./sq. in.*	*lb./sq. in.*	*lb./sq. in.*	*lb./sq. in.*	*lb./cu. in.*	*in.*	*lb./sq. in.*	*lb./sq. in.*	*lb.*	*lb.*	*lb.*	*in.-lb./cu. in.*
Danta (*Cistanthera papaverifera*)	78	69	6,370	11,800	3,650	6,120	11·5	31[2]	1,470,000	1,220	1,530	1,590	1,330	1·48
Hickory, pignut (*Hicoria glabra*)	54	64	6,200	11,700	3,950	4,810	31·7	89	1,650,000	1,140	—	—	—	1·34
Hickory, shagbark (*Hicoria ovata*)	60	64	5,900	11,000	3,430	4,580	23·7	74	1,570,000	1,000	—	—	—	1·28
Hickory, big shellbark (*Hicoria laciniosa*)	61	53	5,600	10,500	2,740	3,920	29·9	104	1,340,000	1,000	—	—	—	1·35
Hickory bitternut (*Hicoria minima*)	66	63	5,500	10,300	4,330	4,570	20·0	66	1,400,000	990	—	—	—	1·22
Hickory, mockernut (*Hicoria alba*)	59	64	6,300	11,100	3,900	4,480	26·1	88	1,570,000	1,000	—	—	—	1·38
Hickory, pecan (*Hicoria pecan*)	63	61	5,200	9,800	3,040	3,990	14·6	53	1,370,000	960	1,310		1,270	1·18
Ash, white (forest grown) (*Fraxinus americana*) . .	43	46	4,900	9,100	3,230	3,800	13·4	36	1,350,000	800	900		1,000	1·03
Ash, white (second growth) (*Fraxinus americana*) . .	40	51	6,100	10,800	3,820	4,610	16·3	47	1,640,000	790	1,080		1,140	1·30
Ash, blue (*Fraxinus quadrangulata*)	39	46	5,700	9,600	3,540	4,180	14·7	43	1,240,000	990	1,030		1,140	1·47
Yon (*Anogeissus acuminata*) .	35	62	8,020	13,140	4,390	6,570	—	44	1,914,000	1,330	1,670	1,580	1,820	1·90
Axle-Wood (*Anogeissus latifolia*)	35	67	6,360	12,100	3,070	5,450	—	57	1,619,000	1,380	1,790	1,790	1,860	1·46

---

[1] *Weight of hammer, 50 lb., except in the case of the Danta wood.*

[2] *Weight of hammer, 100 lb., equivalent to approximately 62 in. for a 50-lb. hammer.*

but a little less so than the Indian woods ; in its shock-resisting ability it is inferior to the best hickories, but appears to be better than ash and quite as good as Yon and Axle wood. It is slightly more flexible than most of the hickories and the strongest ash, and is less liable to breakage than Yon, which is the stiffest of the woods in question.

RESULTS OF TESTS ON THE AIR-DRIED TIMBER

The tests on air-dried timber are carried out at a standard moisture content of approximately 12 per cent., and a long period of natural seasoning proved to be necessary before the Danta timber attained this condition.

The same procedure was adopted in carrying out the tests on the air-dried timber as in the case of the green timber. The air-dried sticks from the two logs D.1 and D.3 (bolts B, C, D and H, K, L respectively) were submitted to the standard tests at the Imperial Institute, and similar tests were carried out by the Forest Products Research Laboratory at Princes Risborough on sticks from the centre log D.2 (bolts E, F and G). The whole of the impact tests were made at the Forest Products Research Laboratory.

The results of the whole of these tests are summarised in the following table :

Summary of Tests on Air-dried Timber

Static Bending :		
Moisture	*per cent.*	12·5
Specific gravity		0·675 [1]
Maximum calculated longitudinal shear	*lb./sq. in.*	562
Fibre stress at limit of proportionality	*lb./sq. in.*	8,750
Fibre stress at maximum load	*lb./sq. in.*	16,130
Modulus of elasticity	*lb./sq. in.*	1,793,000
Work to limit of proportionality	*in.-lb./cu. in.*	2·38
Work to maximum load	*in.-lb./cu. in.*	12·4
Total work	*in.-lb./cu. in.*	26·3
Compression Parallel to Grain :		
Moisture	*per cent.*	11·7
Specific gravity		0·670[1]
Fibre stress at limit of proportionality	*lb./sq. in.*	5,240
Fibre stress at maximum load	*lb./sq. in.*	9,160
Modulus of elasticity	*lb./sq. in.*	1,990,000

[1] *Based on dry weight and volume as tested.*

Summary of Tests on Air-dried Timber—continued

Compression Perpendicular to the Grain :		
Moisture	*per cent.*	12·3
Specific gravity		0·665 [1]
Fibre stress at limit of proportionality	*lb./sq. in.*	1,890
Hardness :		
Moisture	*per cent.*	12·1
Specific gravity		0·669 [1]
Load per impression, lb. Radial		1,610
Load per impression, lb. Tangential		1,770
Load per impression, lb. End		1,590
Impact Bending [2] (100-lb. Hammer) :		
Moisture	*per cent.*	11·9
Specific gravity		0·660 [1]
Fibre stress at limit of proportionality	*lb./sq. in.*	18,850
Modulus of elasticity	*lb./sq. in.*	2,615,000
Work to limit of proportionality	*in.–lb./cu. in.*	7·57
Drop causing complete failure	*in.*	19 [3]
Shear :		
Moisture	*per cent.*	11·9
Shearing strength (lb./sq. in.) Radial		1,986
Shearing strength (lb./sq. in.) Tangential		1,724
Cleavage :		
Moisture	*per cent.*	12·0
Splitting strength (lb./in. width) Radial		499
Splitting strength (lb./in. width) Tangential		605
Tension Perpendicular to the Grain :		
Moisture	*per cent.*	12·0
Tensile strength (lb./sq. in.) Radial		977
Tensile strength (lb./sq. in.) Tangential		1,148
Shrinkage (Volumetric) :		
Moisture	*per cent.*	13·2
Specific gravity		0·697 [4] (1·040 green)
Volume shrinkage	*per cent.*	8·2 [5]
Shrinkage (Linear) :		
Moisture	*per cent.*	12·2
Shrinkage (radial)	*per cent.*	3·6 [6]
Moisture	*per cent.*	12·5
Shrinkage (tangential)	*per cent.*	4·0 [6]

---

[1] *Based on dry weight and volume as tested.*

[2] *Tests carried out at Princes Risborough.*

[3] *Tests on bolts B, C, D, H, K and L were also made with a 50-lb. hammer, and the average height of drop causing complete failure was 33 in.*

[4] *Based on dry weight and dry volume.*

[5] *Based on volume at given moisture content. Shrinkage green to air-dry.*

[6] *Based on width at given moisture content. Shrinkage green to air-dry.*

The air-dried timber had an average weight of 46·8 lb. per cubic foot at 12 per cent. moisture content.

The table opposite gives a comparison of the strengths

STRENGTH VALUES OF AIR-DRIED TIMBER

Species.	Moisture content.	Weight (air-dry).	Static Bending Strength.		Crushing Strength.		Shock-resisting Ability.		Stiffness.	Compression Perpendicular to Grain. Hardness.				Toughness.
			Fibre Stress.		Fibre Stress.						Load per impression.			
			At limit of proportionality.	At maximum load.	At limit of proportionality.	At maximum load.	Work to maximum load (static bending).	Height of drop (50-lb. hammer) (impact bending).	Modulus of elasticity (static bending).	Fibre stress at limit of proportionality.	Radial.	Tangential.	End.	Work to limit of proportionality in static bending.
	Per cent.	*lb./cu. ft.*	*lb./sq. in.*	*lb./sq. in.*	*lb./sq. in.*	*lb./sq. in.*	*in.-lb./cu. in.*	*in.*	*lb./sq. in.*	*lb./sq. in.*	*lb.*	*lb.*	*lb.*	*in.-lb./cu. in.*
Danta (Gold Coast) (*Cistanthera papaverifera*)	12·0	47	8,750	16,130	5,240	9,160	12·4	33	1,793,000	1,890	1,610	1,770	1,590	2·38
Hickory, pignut (U.S.A.) (*Hicoria glabra*)	9·6	53	12,700	22,500	—	10,640	30·2	70	2,410,000	2,860	—	—	—	3·87
Hickory, shagbark (U.S.A.) (*Hicoria ovata*)	9·4	50	11,900	22,600	—	10,700	26·3	65	2,290,000	2,470	—	—	—	3·55
Hickory, big shellbark (U.S.A.) (*Hicoria laciniosa*)	8·7	48	9,800	20,500	—	9,710	22·4	84	2,040,000	2,660	—	—	—	2·59
Hickory, bitternut (U.S.A.) (*Hicoria minima*)	9·2	46	10,300	18,800	—	10,600	17·9	66	1,880,000	2,390	—	—	—	3·19
Hickory, mockernut (U.S.A.) (*Hicoria alba*)	8·9	50	13,500	21,600	—	10,610	22·0	74	2,380,000	2,540	—	—	—	4·19
Hickory, pecan (U.S.A.) (*Hicoria pecan*)	6·2	46	12,000	16,200	6,170	10,890	13·4	41	1,940,000	3,350	2,140		2,370	4·33
Ash, white (forest grown) (U.S.A.) (*Fraxinus americana*)	8·7	40	10,200	16,800	5,600	8,190	15·1	36	1,810,000	1,540	1,320		1,950	3·29
Ash, white (second growth) (U.S.A.) (*Fraxinus americana*)	9·5	44	13,000	18,600	8,500	9,420	17·0	46	1,980,000	2,090	1,680		2,240	4·80
Ash, blue (U.S.A.) (*Fraxinus quadrangulata*)	9·6	40	8,700	14,800	6,120	7,740	14·3	42	1,430,000	1,910	1,360		1,890	3·00
Ash, black (U.S.A.) (*Fraxinus nigra*)	10·4	34	8,300	13,900	5,070	6,890	15·5	36	1,680,000	1,080	890		1,250	1·84
Yon (Burma) (*Anogeissus acuminata*)	13·4	55	11,430	19,320	6,280	9,430	—	47	2,174,000	2,235	2,400	2,560	2,885	3·51
Axlewood (U.P.) (*Anogeissus latifolia*)	14·0	57	6,240	13,290	3,340	5,870	—	36	1,620,000	1,795	1,845	1,880	2,095	1·41
Axlewood (Madras) (*Anogeissus latifolia*)	9·9	59	9,650	16,070	4,750	7,930	—	49	1,937,000	1,800	2,585	2,310	2,145	2·72
Ash (English) (*Fraxinus excelsior*)	13·7	44	6,060	13,200	3,160	6,080	9·6	46	1,761,000	1,130	1,688	1,645	1,698	1·17

of Danta and other timbers ordinarily used for the manufacture of tool handles, as determined by standard tests on the green timber.

The figures for the air-dried material indicate that in comparison with English Ash, Danta is equally flexible, stronger in compression and static bending, and slightly tougher and harder, but possesses rather less shock-resisting ability. Danta is more flexible than any of the Hickories and Indian Yon, and approximately equal in this respect to the American Ashes and to Indian Axlewood. In shock-resisting ability it is inferior to most of these timbers, and it is less strong, hard and tough than the Hickories and Yon. Danta is, however, as strong and hard, if not so tough, as the American Ashes, and it is slightly stronger than Axlewood though not so hard.

This comparison with the results recorded for timbers ordinarily used for tool handles suggests that Danta should prove suitable for the manufacture of the cheaper grades of handles and where high shock-resisting ability is not of paramount importance.

WORKING QUALITIES

The working qualities of air-dried Danta timber were determined at the Forest Products Research Laboratory, Princes Risborough, and the following report was furnished by the Director of the Laboratory.

Machining Qualities

Rip-sawing.—Little difficulty is experienced in sawing this timber and a medium hardwood saw with 15° hook on the teeth will cut it cleanly and readily.

Surfacing.—The timber planes with moderate ease on the overhand planer but " picks up " owing to its interlocked grain.

Thicknessing.—A better finish is obtained with the panel planer, especially with the type of machine employing the skewed and lipped cutter block. The slowest feed speed should be used and thin sharp edges maintained on the cutters in order to reduce the tendency to " pick up." A fair amount of sanding and scraping is required for a smooth finish.

Dimension Cross-cut Saw.—It cuts fairly smoothly across the grain with this type of saw and has very little tendency to chip out.

Band-sawing.—Circles and curves can be sawn cleanly and easily.

Drilling. Three-winged Bit.—A very smooth surface of cut is obtained at the fast speed but slight charring occurs. The medium and slow speeds give fairly good results and the wood does not char.

Drilling. Morse Twist Drill.—The fast speed gives smooth cutting but the wood chars slightly. No charring occurs with the medium and slow speeds but the surface of cut is somewhat rough.

Recessing.—Satisfactory results are obtainable.

Mortising.—The chain mortiser cuts cleanly and very little chipping out occurs.

The hollow chisel works without difficulty but leaves a somewhat rough surface within the slot.

Moulding. French Spindle Head.—Very good results are obtainable with this type of head and it is recommended for use with this timber.

Moulding. Collar Spindle Head.—Fair results are obtainable, but there is a tendency for " picking up " and chipping out of edges to occur owing to the interlocked grain.

Moulding. Block Head.—A considerable amount of " picking up " occurs in moulding with this type of head.

Turning.—The wood turns readily with both hand and machine tools and after sanding a good smooth finish is obtained.

Handworking Qualities

Planing.—The timber is fairly easy to plane but " picks up," especially on quarter-sawn material, owing to the interlocked or alternating spiral grain.

Sanding and Scraping.—It lends itself to sanding and scraping, but requires a considerable amount owing to the depth of the " picking up." The finished surface shows an attractive ribbon grain.

Staining.—It takes water, spirit and oil stain, but with a somewhat patchy effect, due to the unequal absorption of the ribbon grain.

Polishing.—The wood polishes satisfactorily when filled but is more suitable for varnish and shellac.

Sawing.—It can be sawn without undue difficulty.

Mortising.—The timber mortises well and pre-boring is not essential.

Nailing.—Tests carried out with 2-in. 11 B.W.G. nails showed that the timber was liable to split, especially when nailed near the ends and edges of boards.

PRACTICAL TRIALS FOR TOOL HANDLES

Specimens of the air-dried timber were submitted to three manufacturers of pick, shovel and tool handles for practical trials. The reports on these trials are as follows:

> A.—" I had two hammer shafts made from the sample of this timber which you sent me; one of them developed a crack, starting from a knot, and had to be taken out of service, the other being still in use.
>
> " The timber appears to be suitable for hammer shafts, and I shall be glad to know whether it is yet commercially obtainable and if so in what form, and to whom enquiries should be addressed."
>
> B.—" In reply to yours of the 14th instant, with reference to the specimen of ' Danta ' wood you were good enough to forward us in May of last year, the only purpose that the size of this wood was suitable to work up into was an ordinary Navvy Pick Handle, which we had made into a 36 in.
>
> " The grain of this wood tore out very badly when turning, and completely spoilt one of the two handles, but this may be due to some extent owing to the wood being very dry; the other handle shows signs of tearing, even when finished. In our opinion the wood is not altogether suitable for handles for our class of trade, largely owing to its colour and weight, which would prejudice same in the eyes of the general public; otherwise, as a pick handle we should say it would stand up to the work and work satisfactorily.

> As to the production cost, we can pass no opinion, as this is unknown to us."
>
> C.—" We thank you for your letters regarding 'Danta' wood, and for the specimen supply sent to us. The latter has now been converted into shovel handles, and we have to-day sent one of these to you, as promised.
>
> " You will appreciate the fact that we can take no further steps in regard to this matter until we know the price per cubic foot landed in this country. If you can obtain this information for us, will you kindly advise us when you are in a position to do so ?
>
> " We note that it is intimated that the price will probably approximate to that of mahogany. If such proves to be the case, we do not think that 'Danta' has the faintest hope of being used for the manufacture of spade and shovel handles. In our opinion, it must show a price decidedly cheaper than English ash to be of any use in this respect."

The manufacturers' reports generally confirm the results of the mechanical tests and suggest that Danta would make satisfactory tool handles, although the colour and weight of the timber might be disadvantageous in some cases.

Commercial Possibilities

Specimens of the timber, together with the results of its examination at the Imperial Institute and at the Forest Products Research Laboratory and the reports of the tool-handle manufacturers, were submitted to the Imperial Institute Advisory Committee on Timbers for their opinion as to the market possibilities of the wood in this country.

The Committee regarded the investigation as one of much interest. There is a definite demand for a satisfactory substitute for American hickory and American ash for tool and implement handles, and a suitable Empire timber would be welcomed by manufacturers. The Committee agreed that selected material of Danta should prove satisfactory for hammer handles and for all but high-class pick and shovel handles, provided that the price of the wood permits of competition with American hickory and ash, and English ash. As regards the comments of manufacturers on the finishing qualities of the wood, the results of the working trials at Princes Risborough indicated that, with modern tools and careful methods, the working qualities of the wood are satisfactory, and well-finished handles should be obtainable. This is an important point since a good, clean finish is essential in this class of manufacture.

The practical trials carried out afforded useful evidence of the technical value of the wood and suggested the desirability of more extended trials if enquiry showed that Danta could be supplied in commercial quantities at a satisfactory price.

The Committee recommended that the Gold Coast authorities should be informed of the position and consulted as to (*a*) prices at which the timber could be landed in this country ; (*b*) what supplies are likely to be available, and whether in sawn planks as well as logs. They stated that, on receipt of this information, they would be glad to consider the feasibility of arranging for further practical trials of the timber.

EUCALYPTUS OILS

Towards the end of 1930, the Secretary for Agriculture, Union of South Africa, forwarded to the Imperial Institute for examination a series of crude oils which had been prepared by the Division of Chemistry by direct steam distillation of the mature leaves and terminal twigs of a number of species of Eucalyptus, which have been introduced into that country. The results of their examination are given in the following pages, together with those of other samples of eucalyptus oils from Seychelles and Australia, which have also been investigated recently at the Imperial Institute.

EUCALYPTUS OILS FROM SOUTH AFRICA

(*E. globulus, E. Maideni and E. sideroxylon*)

Owing to their similarity these three oils may be considered conveniently together.

Description

The *Eucalyptus globulus* and *E. Maideni* oils were somewhat turbid owing to the presence of moisture, but the *E. sideroxylon* oil was quite clear ; they all possessed an odour of cineole. The oils, after being rendered clear by filtration, were pale brownish-yellow.

The oils were examined with the results shown (on page 128) in comparison with the recorded constants for the oil of each species and with the British Pharmacopœia requirements for rectified medicinal eucalyptus oil.

The results of examination show that as crude medicinal oils the present samples are of very satisfactory quality, the percentages of cineole comparing very favourably with the recorded amounts in the corresponding oils prepared in Australia. It may be noted, in particular, that the *E. Maideni* oil contains considerably more cineole than the Australian product examined by Baker and Smith.

These oils contain cineole in excess of the requirements of the British Pharmacopœia, and their constants (with the exception of the solubility of the *E. globulus* oil) are in agreement with the Pharmacopœia standards. The oils would, however, require rectification by re-distillation in order to render them suitable for pharmaceutical use in the United Kingdom.

As regards the *E. globulus* oil, if a small fraction representing the higher-boiling portion of the oil were separated during the process of rectification, a more soluble oil containing a higher percentage of cineole should be obtained. Moreover, eucalyptus oils commonly contain small quantities of aliphatic aldehydes (such as iso-valeric aldehyde) having irritating odours which cause coughing. Their presence in the present sample of *E. sideroxylon* oil was particularly noticeable. As the boiling points of these aldehydes are comparatively low they would be the first constituents of the oil to distil over during rectification, and a small first fraction containing them could thus be readily separated.

The yield of oil obtainable in South Africa from the

—	*E. globulus.*		*E. Maideni.*		*E. sideroxylon.*		British Pharmacopœia requirements for rectified eucalyptus oil.
	Present sample.	Recorded figures.[1]	Present sample.	Recorded figures.[2]	Present sample.	Recorded figures.[1]	
Specific gravity at 15/15° C.	0·9178	0·910 to 0·930	0·9227	0·9247	0·9224	0·919 to 0·923	0·910 to 0·930
Optical rotation α_D	+ 5·65° at 18° C.	+0·5° to +12°	+ 2·65° at 16° C.	+ 5·8°	+ 2·47° at 19° C.	+ 0·5° to + 3·1°	− 10° to + 10°
Refractive index, n_D 20°	1·4635	1·460 to 1·470	1·4627	1·4679	1·4630	1·4612 to 1·4725 (1·4725 at 16° C.)	—
Cineole, per cent.:							
By phosphoric acid method	69	50 to 70	83	About 50	78	58 to 72	Not less than 55
By Cocking's cineole-*o*-cresol method	67·7	—	74·8	—	76·9	—	—
Phellandrene	B.P. test negative	—	B.P. test negative	—	B.P. test negative	—	Must show absence of oils containing much phellandrene
Solubility in 70 per cent. alcohol at 15° C.	Soluble in 10 to 5 vols.	Soluble in 1½ to 3 vols.	Soluble in 2·5 vols.	Soluble in 1½ vols.	Soluble in 2·4 vols.	Soluble in 1¼ vols.	Soluble in 5 vols.

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[1] *Compiled from Bull. No. 2, Technological Museum, Sydney*, p. 15; *Baker and Smith, "A Research on the Eucalypts and their Essential Oils," Second Edition*, 1920; *Parry, "Chemistry of Essential Oils," Vol.* 1, 1918.

[2] *One oil only* (*Baker and Smith, loc. cit.*, p. 114).

twigs and leaves of each of these three species of eucalyptus would be an important factor in their commercial production. According to Baker and Smith the fresh leaves and terminal branchlets of *E. globulus* and *E. Maideni* yield in Australia only about 1 per cent. of oil, and *E. sideroxylon* about half to three-fourths of this amount, and in that Dominion pharmaceutical oils are therefore now being largely produced from species giving higher yields of oil, such as *E. Australiana*, the fresh green material of which yields on the average 3 to 3·5 per cent. of crude oil stated to contain 63 to 65 per cent. of cineole.

The oils were submitted to a firm of manufacturing druggists in London, who furnished the following observations :

> " The question as to whether producers could obtain a satisfactory market for these types of oil would depend upon the aroma of the oil, and the absence of objectionable aldehydes, which produce coughing when the oil is used.
>
> " There is no question that there is an over-production of medicinal eucalyptus oil at the present time, not only from Australia, but also from Spain. For instance, the B.P. oil containing 70 to 75 per cent. of cineole can be bought at 1*s.* 1*d.* per lb. c.i.f. London (December, 1930), and it is difficult to see how it can pay producers to sell at this rate. Our own view is that the authorities in South Africa should be advised that there is undoubtedly an over-production of eucalyptus oil, and so far as can be foreseen, there is little probability of very much higher prices being obtained for some years to come.
>
> " All grades of eucalyptus oil are in good supply, and there is no shortage of any particular quality which would entitle us to recommend that distillation of any type of oil be carried out on a commercial basis."

As indicated in the preceding statement, the recent market position of medicinal eucalyptus oil has been very unsatisfactory to the producers. The price of the oil in London has declined steadily from about 2*s.* per lb. in

1927 to 1*s.* 1*d.* per lb. at the present time (January, 1931), and it is stated that at the latter figure its production is unremunerative. In these circumstances it seems probable that there may be a considerable fall in the production unless the price improves.

The present time therefore appears inopportune to start the distillation of medicinal eucalyptus oils in South Africa, on a commercial scale, with a view to exporting the oil. There is, however, no doubt that oils of satisfactory quality could be produced in South Africa whenever the market conditions are more favourable.

Eucalyptus Dives Oil from South Africa

This sample consisted of a clear, very pale brownish-yellow oil with a peppermint odour.

The oil was examined with the following results, which are shown in comparison with the range of corresponding figures recorded for *E. dives* oil used commercially as a source of piperitone:

	Present sample.	Recorded figures for commercial *E. dives* oil.
Specific gravity at 15/15° C. . .	0·886	0·8892 to 0·9062
Optical rotation α_D	— 68·10° at 21° C.	— 42° to — 71°
Refractive index n_D 20° C. . .	1·4792	1·4769 to 1·4814
Piperitone (by normal sulphite method) *per cent.*	37	40 to 50
Cineole (by Cocking's cineole-*o*-cresol method) *per cent.*	12	—
B.P. Phellandrene test . . .	Copious precipitate	—

From these results it will be seen that the constants of the present sample are generally similar to those recorded for the commercial *E. dives* oil.

The oil was submitted to a firm of essential oil distillers in London, who stated that it would be of comparatively low value in the United Kingdom (not more than 9*d.* per lb., December, 1930), owing to the small percentage of piperitone present. The amount of piperitone varies in different varieties of *E. dives* oil and it is only the oils containing the highest percentages of this constituent which are of commercial interest in the United Kingdom.

The present oil would appear to be suitable for use for mineral flotation purposes.

Until comparatively recently the principal use of

E. dives oil was in mineral separation, but the discovery that piperitone can be readily converted into thymol and menthol led to the utilisation of the oil for this purpose and the consequent establishment of a new industry in Australia. According to Penfold and Morrison (*Journ. and Proc. Roy. Soc., N.S.W.*, 1927, **61**, 54) there are three distinct varieties of *E. dives,* which are sometimes found in close proximity and show little outward difference, although their leaves yield oils varying considerably in composition and in some cases containing as little as 5 per cent. of piperitone. In consequence, oils have been offered on the market containing amounts of piperitone much below the standard demanded.

Eucalyptus Diversicolor Oil from South Africa

This was a clear, brownish-yellow oil. The oil had an odour of cineole (which, however, was not very pronounced), and also possessed a rather noticeable irritating odour.

The oil was examined with the following results, which are shown in comparison with those recorded for three samples of *Eucalyptus diversicolor* oil examined in Australia by Baker and Smith [1]:

—	Present sample.	Results recorded by Baker and Smith.		
		1.	2.	3.
Specific gravity at 15/15° C.	0·9024	0·8948	0·9083	0·9145
Optical rotation α_D	+ 26·86° at 18° C.	+ 20·5°	+ 20·5°	+ 30·1°
Refractive index n_D 20° C.	1·4705	1·4671	1·4748	1·4727
Acid value	1·1	—	—	—
Aldehydes (by the bisulphite method) *per cent.*	5	—	—	—
Ester value	73·2 [2]	50·7	41	53·2
Ester value after acetylation	87·2 [2]	101·5	83·8	—
Cineole (by Cocking's cineole-*o*-cresol method), per cent. of original oil	22·1	—	—	—
Phellandrene	B.P. Test negative	—	—	Absent
Solubility in 80 per cent. alcohol at 15° C.	Soluble in 7 vols.	Soluble in 4 vols.	—	Soluble in 1 vol.

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[1] "*A Research on the Eucalypts and their Essential Oils,*" *2nd Edition*, 1920.

[2] *Determined on aldehyde-free oil.*

These results show that the characters of the present oil are similar to those recorded for *E. diversicolor* oil produced in Australia.

As this oil contains comparatively little cineole, it could not be economically fractionated and rectified for medicinal use.

The figure obtained for the ester value after acetylation indicates the presence of about 24 per cent. of total alcohols (expressed as $C_{10}H_{18}O$) in the original oil. Judging from the results of the investigation of this oil in Australia by Baker and Smith these alcohols would consist mainly of terpineol with a little geraniol. According to these authors the principal constituent of the oil is *d*-α-pinene.

The oil is not of interest for perfumery as it does not contain a sufficient quantity of any constituent likely to be of value for this purpose. It might be suitable for use in mineral separation, but if the yield from *E. diversicolor* in South Africa is the same as that found in Australia by Baker and Smith, viz. only about 1 per cent., it seems unlikely that it could be produced remuneratively for this purpose.

EUCALYPTUS STAIGERIANA OIL FROM SOUTH AFRICA

This sample consisted of a clear, very pale brownish-yellow oil, with a pleasant odour in which that of citral largely predominated.

The oil was examined with the results shown (on page 133) in comparison with the corresponding figures recorded by Australian investigators for samples of *E. Staigeriana* oil.

The chemical composition, as given by Baker and Smith, of the above-mentioned sample of *E. Staigeriana* oil examined by them is compared in the following table with that of the present oil as deduced from the results of the above examination :

	Present sample.	Oil examined in Australia by Baker and Smith.
	Per cent.	*Per cent.*
Limonene	Not more than 50	Over 60
Citral	30	16
Alcohols (expressed as geraniol)	8·4	11·6
Esters (expressed as geranyl acetate)	11·7	8·3

—	Present sample.	Figures recorded in Australia by		
		Baker and Smith.[1]	Penfold.[2]	
			(a)	(b)
Specific gravity at 15/15° C.	0·8771	0·8715	0·8777	0·8822
Optical rotation α_D	− 34·39° at 20° C.	− 37·53°	− 34·6°	− 26·4°
Refractive index, n_D 20° C.	1·4790	1·4814	1·4793	1·4797
Acid value	2·2	—	—	—
Ester value, expressed on the aldehyde-free oil	47·8	28·3	—	—
Ester value after acetylation, expressed on the aldehyde-free oil	90·3	78·5	—	—
Aldehydes . *per cent.*	30[3]	16[4]	28[5]	38[5]
Solubility in 80 per cent. alcohol	Soluble in 9 vols.	Soluble in 8 vols.	Soluble in 1 vol.	Soluble in 1 vol.

[1] *"A Research on the Eucalypts and their Essential Oils," Second Edition,* 1920, *p.* 320.

[2] *Bull. No.* 5, *Technological Museum, Sydney,* 1923, *p.* 15.

[3] *By the normal sulphite method.*

[4] *By the bisulphite method.*

[5] *By the Burgess method.*

The oil was submitted to a firm of essential oil distillers in London, who considered that it might find an outlet for certain purposes but that its use would be very limited. They were of opinion that if offered in small quantities the oil might realise from 4*s.* 6*d.* to 5*s.* per lb. in the United Kingdom (December, 1930).

This oil could probably be utilised as a cheap substitute for lemon oil, especially for the flavouring of confectionery. Citral is the only constituent of special value which is possibly present in sufficient quantity to be worth extracting, and it seems unlikely that the oil could be profitably utilised for this purpose in competition with lemongrass oil (containing 70 to 85 per cent. of citral), which was recently quoted in London at 2*s.* 3½*d.* to 2*s.* 4½*d.* per lb. (January, 1931). In this connection it may, however, be mentioned that lemongrass in the fresh condition is recorded as only yielding 0·2 to 0·4 per cent. of oil, whereas according to Penfold the fresh leaves of *E. Staigeriana* have been found in Australia to yield up to 1·2 to 1·3 per cent. of oil.

EUCALYPTUS CITRIODORA OIL FROM SOUTH AFRICA

This was a clear, very pale brownish-yellow (almost colourless) oil and possessed the characteristic odour of *E. citriodora* oil.

The oil was examined with the following results, which are shown in comparison with those recorded for *E. citriodora* oil.

	Present sample.	Recorded figures.
Specific gravity at 15/15° C.	0·8764	0·861 to 0·905
Optical rotation α_D	+ 0·30° at 17° C.	− 1·15° to + 2° C.
Refractive index n_D 20° C.	1·4572	1·4498 to 1·4678
Acid value	2·8	—
Ester value	16·6	—
Ester value after acetylation	265·7	—
Total acetylisable constituents (expressed as $C_{10}H_{18}O$)	91·3	Up to 98·5
Solubility in 70 per cent. alcohol at 15° C.	Soluble in 4 vols.	Many oils soluble in 4 to 6 vols.

The above figures indicate that the present oil is of good quality and contains a high percentage of citronellal.

The oil was submitted to a firm of essential oil distillers in London, who stated that it had the characteristics of *E. citriodora* oil of normal quality and would be worth from 7*s*. to 8*s*. per lb. in the United Kingdom (December, 1930). They mentioned, however, that the market for the oil is somewhat limited.

Although this sample represents a marketable oil it is not likely that large quantities could be disposed of at the price quoted by the distillers, and if it should be desired to find a wider market the oil would probably have to be offered at a price enabling it to compete with Java citronella oil, which contains from 80 to 92 per cent. of acetylisable constituents (mainly geraniol and citronellal), and was recently quoted on the London market at 2*s*. 4*d*. per lb. (January, 1931).

EUCALYPTUS OIL FROM SEYCHELLES

A sample of oil which was stated to have been distilled from the leaves of a eucalyptus tree fourteen months old, was received from the Director of Agriculture, Seychelles, in May, 1930. No information was furnished as to the species from which the oil was derived. The yield of oil from the fresh leaves, obtained in a still of rudimentary type, was 0·81 per cent.

The sample was slightly turbid owing to the presence of moisture. After filtration the oil was clear, pale yellowish-brown, and had a pleasant odour resembling that of citronella oil.

The oil was found to have the following constants :

Specific gravity at 15/15° C. . .	0·8772
Optical rotation α_D	+ 2·37° at 22° C.
Refractive index n_D 20° C. . . .	1·458
Acid value	2·5
Ester value	15·2
Ester value after acetylation . .	270·8
Total acetylisable constituents (expressed as $C_{10}H_{18}O$) *per cent.*	93·5
Geraniol (by phthalic anhydride method) *per cent.*	15·3

The quantity of oil was not sufficient to permit of the isolation and definite identification of the constituents present, but judging from the above figures and the odour of the oil it would appear to consist principally of citronellal and geraniol, and thus to resemble Java citronella oil in composition although containing less geraniol than the latter. The Java oil contains from 80 to 92 per cent. of acetylisable constituents (expressed as $C_{10}H_{18}O$), consisting mainly of a mixture of geraniol and citronellal in which the citronellal predominates.

The constants of the present oil are similar to those recorded for the oil of *Eucalyptus citriodora.* The acetylisable constituents of the latter, however, consist almost entirely of citronellal, whereas the results of examination indicate that the Seychelles oil contains an appreciable amount of geraniol.

This oil should find a market in the United Kingdom as a substitute for Java citronella oil, which is largely employed as a perfume for soaps. It was considered by a commercial expert consulted by the Imperial Institute that the Seychelles oil would have a similar value to the Java product, which at the time was realising 2*s.* 4½*d.* per lb. in London (July, 1930).

Eucalyptus Macarthuri OIL FROM AUSTRALIA

A sample of *Eucalyptus Macarthuri* oil was forwarded at the request of the Imperial Institute by the Curator of the Technological Museum, Sydney, for submission to a firm of essential oil distillers in London, who had expressed a wish to obtain a quantity for examination.

The sample consisted of a clear yellowish-brown oil. The odour of geranyl acetate could be readily detected, but the oil also had a sharp, not very pleasant odour.

On examination at the Imperial Institute the oil was found to have the following constants, which are shown in comparison with the corresponding figures recorded in Australia for the oil of *E. Macarthuri* leaves :

	Present sample.	Recorded figures.[2]
Specific gravity at 15·5/15·5° C.	0·9344	0·9174 to 0·9292
Optical rotation α_D 20° C. .	+ 2·69°	+ 0·69° to + 3·6°
Refractive index n_D 20° C. .	1·473	1·469 to 1·4744
Acid value	20·7[1]	—
Ester value	144·9	—
Esters (as geranyl acetate) *per cent.*	50·7	60 to 77
Ester value after acetylation .	217·1	—
Free alcohols (as geraniol) *per cent.*	21	2·6 to 10·6
Total alcohols (as geraniol) *per cent.*	60·8	—
Solubility in 70 per cent. alcohol at 15° C.	Soluble in 3·2 vols.	Soluble in 1·2 to 1·5 vols.

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[1] *This would be equivalent to* 2·2 *per cent. of acetic acid.*

[2] *Penfold, Bulletins No.* 2 (1924) *and No.* 5 (1923), *Technological Museum, Sydney* ; *Smith, "Journal of the Royal Society of New South Wales,"* 1900, **34**, *p.* 142 ; *Baker and Smith, " A Research on the Eucalypts," Second Edition,* pp. 315, 316 *and* 367.

The foregoing results show that the oil contains an appreciable amount of free acid, presumably acetic acid, which imparts the sharp odour to the oil. It would thus appear that the geranyl acetate had partially hydrolysed as the amount of free alcohols present (calculated as geraniol) was higher than any of the corresponding recorded figures for the oil of *E. Macarthuri.* Judging, however, from the range of figures recorded in Australia for the amounts of esters and alcohols in this oil, the percentage of total alcohols in the present sample, calculated as geraniol, would appear to represent about the average value.

It may be noted that the specific gravity of the present oil is rather higher than that of any sample of this oil of which a record is available.

The oil was submitted to the firm of essential-oil distillers on whose behalf it was obtained, and the following report was furnished by their chemist :

> "We find that this oil contains geraniol, linalool, eudesmol and possibly nerol, their esters of acetic and higher fatty acids, and also cineole and free acids. The geraniol, which we isolated in about 35 per cent. yield, has a very sweet odour suggesting palmarosa oil. I should place the value of this oil at almost 75 per cent. of that of palmarosa.
>
> "I think that we could use considerable quantities of this oil if it is available."

In view of the results of this investigation, the Australian authorities have been asked to furnish information as to the possibility of producing this oil on a commercial scale for shipment to the United Kingdom, and the price at which it could be offered.

THE TANNING VALUE OF *ANOGEISSUS LATIFOLIA* LEAVES.—II

In a previous number of this BULLETIN (1929, **27**, 452) a report was published on the results of investigation of three samples of leaves of *Anogeissus latifolia* collected in Madras. The leaves had been prepared by the customary method of drying in the shade. As, however, difficulties had been experienced in the past in shade-drying large quantities of the leaves, the Imperial Institute suggested that it would be desirable to determine the quality of leaves prepared by drying in the sun. In response to this suggestion three samples of sun-dried *Anogeissus latifolia* leaves were forwarded by the Deputy Forest Utilisation Officer, Chepauk, Madras, in May 1930.

The samples were as follows :

A. "*Pale green tender leaves.*"—Thin dried leaves, up to 1½ in. in length and from ⅜ to 1¼ in. broad. The colour varied from pale green to reddish-brown. The majority of the leaves were broken, and a fair proportion of stalk was present. The material generally resembled Sample A of shade-dried *A. latifolia,* which was dealt with in the previous report, but the latter was free from stalk and the leaves were larger.

B. " Large green tender leaves."—Pale green leaves, from 1 to 2½ in. in length and ¾ to 1¾ in. in breadth. The sample was in clean condition and almost free from stalk. The material was similar to that of the shade-dried Sample B previously examined, but the leaves were paler and slightly smaller.

C. " Very young leaves and top-shoots."—Small broken leaves and stalks, brownish-green to dark reddish-brown in colour. The few unbroken leaves present measured ½ to ¾ in. in length, and ¼ to ¾ in. in width. The sample resembled the shade-dried " Dhawa Sumac " described in the earlier report, but contained less stalk.

The samples were examined with the following results, which are shown in comparison with those obtained for the shade-dried materials previously reported on :

—	Sun-dried samples.			Shade-dried samples.		
	A Small leaves.	*B* Large leaves.	*C* "Dhawa Sumac" (young leaves and stalks).	*A* Small leaves.	*B* Large leaves.	*C* " Dhawa Sumac" (young leaves and stalks).
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . .	11·8	11·5	12·7	12·8	12·3	14·0
Insoluble matter .	42·9	53·9	37·0	44·3	44·5	33·7
Extractive matter (non-tans) .	17·1	15·1	15·2	10·0	11·0	13·8
Tannin . .	28·2[1]	19·5[1]	35·1[1]	32·9[2]	32·2[2]	38·5[2]
Ash . . .	3·7	4·6	4·0	4·4	3·9	4·0
Tintometer Readings[3] :						
Red . .	1·2	1·7	2·5	1·5	1·7	1·9
Yellow . .	6·4	9·3	11·8	4·9	5·0	6·5

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[1] *By the official International Method of Tannin Analysis (Hide Powder Batch C.*3).

[2] *By the method prescribed by the International Association of Leather Trades' Chemists (Hide Powder Batch B.*11).

[3] *Determined for a solution containing* 0·5 *per cent. of tannin in a* 1 *centimetre cell.*

The results of analysis show that each of the present samples contained less tannin than the corresponding sample previously examined. As regards the two samples of quality A and the two samples of quality C, the decrease in tannin amounted to less than 5 units per cent., but the difference was greater in the case of samples B, the present sun-dried sample containing about 13 units less of tannin. It will be observed that the present samples contained rather larger amounts of soluble non-tans.

Portions of the samples were submitted to Prof. D. McCandlish of the Leather Industries Laboratories of Leeds University, who had also examined the earlier samples and prepared leathers from them. Prof. McCandlish reported as follows on the present samples in comparison with the shade-dried materials :

> " I have pleasure in enclosing five samples of leather tanned with shade-dried and sun-dried leaves of *Anogeissus latifolia* received from you. The colour of all the samples is sufficiently satisfactory to suggest that the material will be of interest to the tanning trade, provided it is available at a price that will make it commercially attractive.
>
> " It should be mentioned that the length of time occupied in tanning raw pelt with this material was about double that which would have been required for tanning with sumach. The pelt used for the tests was normal in every way, but it may be that some increase in the speed of tannage may be realised by adjusting the *p*H of the pelt slightly, or by finely grinding the leaves before use, although we have not enquired into this aspect of the matter."

The foregoing results, together with specimens of the leathers produced, were submitted to the Imperial Institute Advisory Committee on Tanning Materials, who considered that it would be advisable to ascertain the probable value of the sun-dried and shade-dried materials on the United Kingdom market, and that with this end in view efforts should be made to arrange for practical trials by tanning firms. It has, therefore, been suggested to the authorities in India that small consignments of about 5 cwt. of each grade of the sun-dried leaves should be forwarded to the Imperial Institute for this purpose, and if possible also a similar quantity of each grade of the shade-dried leaves.

SOILS FROM BERMUDA

Detailed knowledge regarding the composition of the soils of Bermuda is very scanty, little information being available beyond a few analyses published by General Lefroy in 1883. In these circumstances the following analyses may be of interest as affording further information concerning the soils of the island.

The six samples of soil which form the subject of the present report were forwarded to the Imperial Institute by the Plant Pathologist, Department of Agriculture, Bermuda, in co-operation with the Imperial Bureau of Soil Science. An examination of the soils was desired primarily with a view to determining, if possible, whether soil conditions were causing a chlorotic condition of some of the crops of Easter lilies grown on the soils. A sample of drifting beach sand, such as forms the foundation of practically all the soils of Bermuda, was also sent.

Results of Examination

The six samples of soil were submitted to chemical and mechanical analysis at the Imperial Institute. All the soils were highly calcareous, and while there is no standard or official method for the mechanical analysis of such soils, it is the practice at the Imperial Institute to determine the amounts of the separate grades without preliminary acid treatment and then to determine the amount of carbon dioxide (from which calcium carbonate is calculated) in each grade. In this way, the size-distribution of the carbonate particles is determined. This is considered to be a matter of importance, as the particles of carbonate of "clay" size present, for example, will be likely to affect the properties of the soil more than those of "coarse sand" size.

The chemical analyses were carried out with the usual modifications for calcareous soils.

The "clay fraction" required for analysis was separated by sedimentation in the usual way and then washed thoroughly with dilute acid in order to remove as much of the calcium and magnesium carbonates as possible.

The determination of the *p*H values was made both in aqueous suspension in the usual way and also in suspension in a normal solution of potassium chloride.

*Soils Nos. A.*1 *and A.*2.—These two soils, which were taken in the same field, a short distance apart, are stated to have shown marked differences in the crops growing on them. The plants grown on A.1 were all chlorotic throughout the season, while those grown on A.2 showed some chlorosis early, but recovered later in the year.

*A.*1.—A deep, highly calcareous soil, light brown in colour. The soil had been sampled to a depth of 12 in.

PRELIMINARY MECHANICAL ANALYSIS ON THE ENTIRE SOIL, WHICH WAS AIR-DRIED BEFORE EXAMINATION

	Size of particles in mm.	Total. *Per cent.*
Stones and gravel	Over 2·0	10·8
"Fine earth"	2·0 and under	89·2

MECHANICAL ANALYSIS OF "FINE EARTH"

	Size of particles in mm.	Total of fraction dried at 105° C. *Per cent.*	$CaCO_3$.[1] *Per cent.*	Remainder. *Per cent.*
Coarse sand . .	2·0 to 0·2	54·3	51·4	2·9
Fine sand . .	0·2 to 0·02	10·4	10·0	0·4
Silt . . .	0·02 to 0·002	12·3	8·0	4·3
Clay . . .	0·002 and under	12·6	4·3	8·3
Moisture at 105° C.		3·85	—	—
Matter soluble in water		0·07	—	—
Calcium carbonate dissolved by dispersion medium		2·7	2·7	
	Total . .	96·22	76·4	15·9
		Per cent.		
Calcium carbonate (total)[1]		77·4	—	—
Loss on ignition[2]		5·99	—	—

Reaction of soil, Alkaline. *p*H value, 8·23 in aqueous suspension; 8·19 in normal KCl suspension.

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[1] *Calculated from the percentage of* CO_2.

[2] *Not including moisture lost at* 105° C. *or* CO_2 *from carbonates.*

CHEMICAL ANALYSIS OF "FINE EARTH"

		Soluble in hydrochloric acid.	Exchangeable bases (Hissink method).
		Per cent.	*Per cent.*
Lime . . .	CaO	42·72	0·192
Magnesia . .	MgO	0·92	0·020
Potash . . .	K_2O	0·15	0·031
Soda . . .	Na_2O	0·19	0·014
Ferric oxide . .	Fe_2O_3	1·67	0·004
Alumina . .	Al_2O_3	2·60	
Manganous oxide .	MnO	0·05	faint trace
Phosphoric acid .	P_2O_5	0·72	—

		Total.	
		Per cent.	*lb. per acre.*
Nitrogen . .	N	0·25	7,546
Organic carbon .	C	2·34	70,632
Organic matter[1] .	. .	4·25	—
Carbon dioxide .	CO_2 .	34·04	—

$$\text{Atomic ratio}\left\{\frac{\text{Carbon, C}}{\text{Nitrogen, N}}\right. = 10{\cdot}9.$$

[1] *Obtained by multiplying the figure for organic carbon by* $\frac{100}{55}$.

The figures for lb. per acre of the various constituents in the above table are calculated for a depth of 12 in. of soil, the apparent specific gravity of the soil being taken into consideration.

Composition of clay fraction (0·002 mm. and under, separated by sedimentation).

		Per cent.
Silica	SiO_2	23·70
Alumina	Al_2O_3	25·31
Ferric oxide	Fe_2O_3	11·48
Titanium dioxide	TiO_2	1·28
Loss on ignition		34·98

$$\text{Molecular ratio}\left\{\frac{\text{Silica, } SiO_2}{\text{Alumina, } Al_2O_3}\right. = 1{\cdot}59.$$

A.2.—A shallow, highly calcareous soil, greyish-brown in colour. The soil had been sampled to a depth of 6 in.

PRELIMINARY MECHANICAL ANALYSIS ON THE ENTIRE SOIL, WHICH WAS AIR-DRIED BEFORE EXAMINATION

	Size of particles in mm.	Total. *Per cent.*
Stones and gravel	Over 2·0	7·5
"Fine earth"	2·0 and under	92·5

MECHANICAL ANALYSIS OF "FINE EARTH"

	Size of particles in mm.	Total of fraction dried at 105° C.	$CaCO_3$.[1]	Remainder.
		Per cent.	*Per cent.*	*Per cent.*
Coarse sand	2·0 to 0·2	52·4	50·9	1·5
Fine sand	0·2 to 0·02	14·2	12·3	1·9
Silt	0·02 to 0·002	8·5	7·0	1·5
Clay	0·002 and under	14·6	9·5	5·1
Moisture at 105° C.		4·02	—	—
Matter soluble in water		0·06	—	—
Calcium carbonate dissolved by dispersion medium		3·2	3·2	—
Total		96·98	82·9	10·0
		Per cent.		
Calcium carbonate (total)[1]		86·0	—	—
Loss on ignition[2]		3·68	—	—

Reaction of soil, Alkaline. *p*H value, 8·42 in aqueous suspension 8·37 in normal KCl suspension.

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[1] *Calculated from the percentage of* CO_2.

[2] *Not including moisture lost at* 105° C. *or* CO_2 *from carbonates.*

CHEMICAL ANALYSIS OF "FINE EARTH."

		Soluble in hydrochloric acid.	Exchangeable bases (Hissink method)
		Per cent.	*Per cent.*
Lime	CaO	46·82	0·316
Magnesia	MgO	0·98	0·040
Potash	K_2O	0·07	0·011
Soda	Na_2O	0·19	0·013
Ferric oxide	Fe_2O_3	0·61	0·006
Alumina	Al_2O_3	1·19	
Manganous oxide	MnO	0·03	faint trace
Phosphoric acid	P_2O_5	0·44	—

		Total.	
		Per cent.	*lb. per acre.*
Nitrogen	N	0·20	3,399
Organic carbon	C	1·90	32,292
Organic matter[1]	.	3·45	—
Carbon dioxide	CO_2	37·84	—

$$\text{Atomic ratio}\left\{\frac{\text{Carbon, C}}{\text{Nitrogen, N}}\right. = 11{\cdot}1.$$

[1] *Obtained by multiplying the figure for organic carbon by* $\frac{100}{58}$.

The figures for lb. per acre of the various constituents in the above table are calculated for a depth of 6 *in. of soil, the apparent specific gravity of the soil being taken into consideration.*

Composition of clay fraction (0·002 mm. and under, separated by sedimentation).

		Per cent.
Silica	SiO_2	21·54
Alumina	Al_2O_3	19·37
Ferric oxide	Fe_2O_3	10·75
Titanium dioxide	TiO_2	1·27
Loss on ignition	.	45·01

$$\text{Molecular ratio}\left\{\frac{\text{Silica,}\quad SiO_2}{\text{Alumina,}\quad Al_2O_3}\right. = 1{\cdot}88.$$

The two soils are very similar in many respects, and are both highly calcareous. In each case, practically the whole of the " stones and gravel " consisted of nodules of limestone. As regards mechanical composition, the size-distribution of particles is very much the same, the " coarse sand " fraction being by far the largest in each soil, but A.2 has a much larger proportion of carbonates in the clay fraction than A.1. The amount of moisture retained by the air-dry soils is small, while soluble salts are low in amount in both cases.

The reaction of the two soils, both in aqueous suspension and in normal potassium chloride suspension, is alkaline, the differences being small and probably insignificant. The alkalinity would appear to be due to the slight but definite solubility of calcium carbonate.

In chemical composition, the outstanding feature of both soils is the very high proportion of acid-soluble lime, which amounts to over 40 per cent., in conjunction with less than 1 per cent. of acid-soluble magnesia. In the " exchangeable " form, however, the lime is relatively low, but still considerably exceeds the magnesia, the ratio of lime to magnesia in this form being somewhat higher in A.1 than in A.2.

The amounts of potash, both acid-soluble and exchangeable, while rather low in both soils, are distinctly higher in A.1 than in A.2. Ferric oxide and alumina are also higher in amount in A.1 than in A.2. Acid-soluble phosphoric acid is present in fair quantity, as is frequent in calcareous soils, but acid-soluble manganese is low in amount and there is only a faint trace of " exchangeable " manganese in both soils.

The quantities of nitrogen and of organic matter are quite satisfactory in both cases, the actual percentages in A.1 slightly exceeding those in A.2, while the ratios of carbon to nitrogen are very similar.

The clay fractions of these two soils are also similar in composition, and both give silica : alumina ratios of less than 2.

B.1.—A very deep, highly calcareous, light brown soil, on which the lilies all showed chlorotic conditions throughout the season. The soil had been sampled to a depth of 12 in.

PRELIMINARY MECHANICAL ANALYSIS ON THE ENTIRE SOIL, WHICH WAS AIR-DRIED BEFORE EXAMINATION

	Size of particles in mm.	Total. *Per cent.*
Stones and gravel	Over 2·0	11·9
"Fine earth"	2·0 and under	88·1

MECHANICAL ANALYSIS OF "FINE EARTH"

	Size of particles in mm.	Total of fraction dried at 105° C. *Per cent.*	$CaCO_3$.[1] *Per cent.*	Remainder *Per cent.*
Coarse sand . .	2·0 to 0·2	39·0	37·9	1·1
Fine sand . .	0·2 to 0·02	13·5	5·7	7·8
Silt . . .	0·02 to 0·002	14·3	6·1	8·2
Clay . . .	0·002 and under	21·3	1·8	19·5
Moisture at 105° C.		5·05	—	—
Matter soluble in water		0·07	—	—
Calcium carbonate dissolved by dispersion medium		4·6	4·6	—
	Total . .	97·82	56·1	36·6
		Per cent.		
Calcium carbonate (total)[1]		61·1	—	—
Loss on ignition[2]		8·73	—	—

Reaction of soil, Alkaline. *p*H value, 8·73 in aqueous suspension; 8·01 in normal KCl suspension.

[1] *Calculated from the percentage of* CO_2.

[2] *Not including moisture lost at* 105° C. *or* CO_2 *from carbonates.*

CHEMICAL ANALYSIS OF "FINE EARTH"

		Soluble in hydrochloric acid. *Per cent.*	Exchangeable bases (Hissink method). *Per cent.*
Lime . . .	CaO	33·23	0·432
Magnesia . .	MgO	0·95	0·041
Potash . . .	K_2O	0·18	0·032
Soda . . .	Na_2O	0·10	0·007
Ferric oxide . .	Fe_2O_3	3·40	0·010
Alumina . .	Al_2O_3	6·56	
Manganous oxide .	MnO	0·11	not detected
Phosphoric acid .	P_2O_5	0·93	—

		Total. *Per cent.*	Total. *lb. per acre.*
Nitrogen . .	N	0·30	8,892
Organic carbon .	C	2·80	82,994
Organic matter[1] .	. .	5·09	—
Carbon dioxide .	CO_2	26·90	—

$$\text{Atomic ratio}\left\{\frac{\text{Carbon, C}}{\text{Nitrogen, N}}\right. = 10{\cdot}9.$$

[1] *Obtained by multiplying the figure for organic carbon by* $\frac{100}{55}$.

The figures for lb. per acre of the various constituents in the above table are calculated for a depth of 12 *in. of soil, the apparent specific gravity of the soil being taken into consideration.*

CHEMICAL ANALYSIS OF "FINE EARTH"—*continued*

Composition of clay fraction (0·002 mm. and under, separated by sedimentation).

		Per cent.
Silica	SiO_2	34·53
Alumina	Al_2O_3	25·37
Ferric oxide	Fe_2O_3	7·90
Titanium dioxide	TiO_2	1·88
Loss on ignition		27·54
Total		97·22

$$\text{Molecular ratio}\left\{\frac{\text{Silica, } SiO_2}{\text{Alumina, } Al_2O_3}\right. = 2{\cdot}31.$$

This soil is highly calcareous, but the total amount of carbonates and the proportions of calcium carbonate in the clay fraction are less than those found in A.1 and A.2.

The amount of moisture retained by the air-dry soil and the quantity of soluble salts present are low in amount.

The soil has an alkaline reaction and there is a slight difference between the *p*H value in aqueous suspension and in normal potassium chloride suspension.

As regards chemical composition, the acid-soluble lime is very high and largely exceeds the magnesia, but the exchangeable lime does not exceed the exchangeable magnesia to the same extent.

The amounts of potash present are fairly satisfactory and the percentages of acid-soluble ferric oxide and alumina are higher than in the samples A.1 and A.2. The acid-soluble phosphoric acid is fairly high and the amount of acid-soluble manganese is higher than in samples A.1 and A.2, although none could be detected in the exchangeable form.

The quantities of nitrogen and of organic matter are high, and the ratio of carbon to nitrogen is normal.

The chemical composition of the clay fraction is normal, the ratio of silica to alumina being a little over 2.

*C.*1 *and C.*2.—These two samples are stated to have been taken from the same field, C.1 having a chlorotic crop, while the plants grown on C.2 showed no signs of chlorosis.

*C.*1.—A calcareous soil, light reddish-brown in colour. The soil had been sampled to a depth of 8 in.

PRELIMINARY MECHANICAL ANALYSIS ON THE ENTIRE SOIL, WHICH WAS AIR-DRIED BEFORE EXAMINATION

	Size of particles in mm.	Total. *Per cent.*
Stones and gravel	Over 2·0	7·1
"Fine earth"	2·0 and under	92·9

MECHANICAL ANALYSIS OF "FINE EARTH"

	Size of particles in mm.	Total of fraction dried at 105° C. *Per cent.*	$CaCO_3$.[1] *Per cent.*	Remainder. *Per cent.*
Coarse sand	2·0 to 0·2	29·4	26·6	2·8
Fine sand	0·2 to 0·02	10·4	7·1	3·3
Silt	0·02 to 0·002	20·5	6·6	13·9
Clay	0·002 and under	24·0	1·4	22·6
Moisture at 105° C.		6·74	—	—
Matter soluble in water		0·09	—	—
Calcium carbonate dissolved by dispersion medium		4·2	4·2	—
Total		95·33	45·9	42·2
		Per cent.		
Calcium carbonate (total)[1]		44·2	—	—
Loss on ignition[2]		11·80	—	—

Reaction of soil, Alkaline. *p*H value, 8·52 in aqueous suspension; 8·15 in normal KCl suspension.

[1] *Calculated from the percentage of* CO_2.

[2] *Not including moisture lost at* 105° C. *or* CO_2 *from carbonates.*

CHEMICAL ANALYSIS OF "FINE EARTH"

		Soluble in hydrochloric acid. *Per cent.*	Exchangeable bases (Hissink method). *Per cent.*
Lime	CaO	24·58	0·493
Magnesia	MgO	0·99	0·034
Potash	K_2O	0·16	0·025
Soda	Na_2O	0·20	0·013
Ferric oxide	Fe_2O_3	5·21	0·007
Alumina	Al_2O_3	10·18	
Manganous oxide	MnO	0·14	faint trace
Phosphoric acid	P_2O_5	0·87	—

		Total. *Per cent.*	Total. *lb. per acre.*
Nitrogen	N	0·39	7,848
Organic carbon	C	3·67	73,851
Organic matter[1]		6·67	—
Carbon dioxide	CO_2	19·44	—

Atomic ratio $\left\{\frac{\text{Carbon, C}}{\text{Nitrogen, N}}\right. = 11{\cdot}0.$

[1] *Obtained by multiplying the figure for organic carbon by* $\frac{100}{55}$.

The figures for lb. per acre of the various constituents in the above table are calculated for a depth of 8 *in. of soil, the apparent specific gravity of the soil being taken into consideration.*

CHEMICAL ANALYSIS OF "FINE EARTH"—*continued*

Composition of clay fraction (0·002 mm. and under, separated by sedimentation).

		Per cent.
Silica	SiO_2	32·69
Alumina	Al_2O_3	23·96
Ferric oxide	Fe_2O_3	11·15
Titanium dioxide	TiO_2	2·01
Loss on ignition		27·20
Total .		97·01

$$\text{Molecular ratio}\left\{\frac{\text{Silica, } SiO_2}{\text{Alumina, } Al_2O_3}\right. = 2{:}32.$$

C.2.—A calcareous soil, light reddish-brown in colour. The soil had been sampled to a depth of 8 in.

PRELIMINARY MECHANICAL ANALYSIS ON THE ENTIRE SOIL, WHICH WAS AIR-DRIED BEFORE EXAMINATION

	Size of particles in mm.	Total. *Per cent.*
Stones and gravel . .	Over 2·0	4·2
"Fine earth" . . .	2·0 and under	95·8

MECHANICAL ANALYSIS OF "FINE EARTH"

	Size of particles in mm.	Total of fraction dried at 105° C.	$CaCO_3$.[1]	Remainder.
		Per cent.	*Per cent.*	*Per cent.*
Coarse sand . .	2·0 to 0·2	25·0	20·7	4·3
Fine sand . .	0·2 to 0·02	11·6	7·1	4·5
Silt . . .	0·02 to 0·002	28·0	4·5	23·5
Clay . . .	0·002 and under	21·8	1·6	20·2
Moisture at 105° C.		7·96	—	—
Matter soluble in water		0·07	—	—
Calcium carbonate dissolved by dispersion medium		3·7	3·7	—
	Total . .	98·13	37·6	52·5

	Per cent.		
Calcium carbonate (total)[1]	36·5	—	—
Loss on ignition[2]	13·28	—	—

Reaction of soil, Alkaline. *p*H value, 8·53 in aqueous suspension 8·09 in normal KCl suspension.

---

[1] *Calculated from the percentage of* CO_2.

[2] *Not including moisture lost at* 105° C. *or* CO_2 *from carbonates.*

Chemical Analysis of "Fine Earth"

		Soluble in hydrochloric acid.	Exchangeable bases (Hissink method).
		Per cent.	*Per cent.*
Lime	CaO	20·95	0·520
Magnesia	MgO	1·06	0·042
Potash	K_2O	0·17	0·030
Soda	Na_2O	0·11	0·019
Ferric oxide	Fe_2O_3	5·95	0·005
Alumina	Al_2O_3	11·89	
Manganous oxide	MnO	0·11	not detected
Phosphoric acid	P_2O_5	0·89	—

		Total.	
		Per cent.	*lb. per acre.*
Nitrogen	N	0·40	7,397
Organic carbon	C	4·01	74,150
Organic matter[1]		7·29	—
Carbon dioxide	CO_2	16·06	—

$$\text{Atomic ratio}\left\{\frac{\text{Carbon, C}}{\text{Nitrogen, N}}\right. = 11{\cdot}7.$$

[1] *Obtained by multiplying the figure for organic carbon by* $\frac{100}{55}$.

The figures for lb. per acre of the various constituents in the above table are calculated for a depth of 8 in. of soil, the apparent specific gravity of the soil being taken into consideration.

Composition of clay fraction (0·002 mm. and under, separated by sedimentation).

		Per cent.
Silica	SiO_2	31·70
Alumina	Al_2O_3	24·37
Ferric oxide	Fe_2O_3	12·10
Titanium dioxide	TiO_2	1·58
Loss on ignition		27·31
Total		97·06

$$\text{Molecular ratio}\left\{\frac{\text{Silica, } SiO_2}{\text{Alumina, } Al_2O_3}\right. = 2{\cdot}21.$$

In physical composition, the soils are very similar, and both are highly calcareous, but the percentage of carbonates in C.1 is higher than in C.2. The size-distribution of the fractions is closely parallel and the proportion of carbonates in the clay fractions, which is likely to be the most active as regards the properties of the soil, is practically the same in both instances.

The reaction of both soils is alkaline, and the variations between the pH values in aqueous and in potassium chloride suspension are small and probably unimportant.

As regards chemical composition, the acid-soluble lime in both soils is high, both in amount and in proportion to the acid-soluble magnesia, and the relative proportions of lime and magnesia in the "exchangeable" form are very similar.

The quantities of potash, both acid-soluble and exchangeable, and of acid-soluble phosphoric acid, approximate closely in the two soils. There are small and similar amounts of acid-soluble manganese in both cases, but the quantities of exchangeable manganese are negligible.

The amounts of nitrogen and of organic matter, which are high, and the ratios of carbon to nitrogen, are also similar.

The clay fractions resemble each other in chemical composition, and both give a ratio of silica to alumina of a little over 2. This ratio is very close to that found in the clay fraction of B.1.

*D.*1.—A highly calcareous, light brown, fairly deep soil, on which lilies showed no signs of chlorosis. The soil had been sampled to a depth of 12 in.

PRELIMINARY MECHANICAL ANALYSIS ON THE ENTIRE SOIL, WHICH WAS AIR-DRIED BEFORE EXAMINATION

	Size of particles in mm.	Total. *Per cent.*
Stones and gravel . .	Over 2·0	6·1
"Fine earth" . . .	2·0 and under	93·9

MECHANICAL ANALYSIS OF "FINE EARTH"

	Size of particles in mm.	Total of fraction dried at 105° C. *Per cent.*	$CaCO_3$[1] *Per cent.*	Remainder. *Per cent.*
Coarse sand . .	2·0 to 0·2	51·3	48·4	2·9
Fine sand . .	0·2 to 0·02	11·4	10·2	1·2
Silt . . .	0·02 to 0·002	16·1	7·5	8·6
Clay . . .	0·002 and under	11·5	3·2	8·3
Moisture at 105° C.		4·75	—	—
Matter soluble in water		0·09	—	—
Calcium carbonate dissolved by dispersion medium		4·0	4·0	—
Total . .		99·14	69·3	21·0

	Per cent.		
Calcium carbonate (total)[1]	72·0	—	—
Loss on ignition[2]	6·29	—	—

Reaction of soil, Alkaline. *p*H value, 8·68 in aqueous suspension; 8·30 in normal KCl suspension.

[1] *Calculated from the percentage of* CO_2.

[2] *Not including moisture lost at* 105° C. *or* CO_2 *from carbonates.*

CHEMICAL ANALYSIS OF "FINE EARTH"

		Soluble in hydrochloric acid. Per cent.	Exchangeable bases (Hissink method). Per cent.
Lime	CaO	38·97	0·341
Magnesia	MgO	1·27	0·029
Potash	K_2O	0·12	0·011
Soda	Na_2O	0·18	0·008
Ferric oxide	Fe_2O_3	2·32	0·007
Alumina	Al_2O_3	4·24	
Manganous oxide	MnO	0·08	not detected
Phosphoric acid	P_2O_5	0·95	—

		Total. Per cent.	Total. lb. per acre.
Nitrogen	N	0·24	7,440
Organic carbon	C	2·39	74,091
Organic matter[1]		4·35	—
Carbon dioxide	CO_2	31·70	—

Atomic ratio $\left\{\frac{\text{Carbon, C}}{\text{Nitrogen, N}}\right. = 11{\cdot}6.$

[1] *Obtained by multiplying the figure for organic carbon by* $\frac{100}{55}$.

The figures for lb. per acre of the various constituents in the above table are calculated for a depth of 12 in. of soil, the apparent specific gravity of the soil being taken into consideration.

Composition of clay fraction (0·002 mm. and under, separated by sedimentation).

		Per cent.
Silica	SiO_2	23·50
Alumina	Al_2O_3	25·22
Ferric oxide	Fe_2O_3	12·40
Titanium dioxide	TiO_2	1·34
Loss on ignition		34·48
Total		96·94

Molecular ratio $\left\{\frac{\text{Silica, } SiO_2}{\text{Alumina, } Al_2O_3}\right. = 1{\cdot}58.$

This soil is very highly calcareous, somewhat resembling A.1 as regards the amount and distribution of carbonates. The moisture retained by the air-dry soil is low in amount, and soluble salts are not present in any quantity.

The soil has an alkaline reaction and the variation between the reaction of the aqueous and of the potassium chloride suspension is small.

The acid-soluble lime is high in amount, while the magnesia is low. The proportions of "exchangeable" lime and magnesia, however, do not differ to the same extent.

The amounts of potash, both acid-soluble and "exchangeable," are rather low. There are fair quantities of acid-soluble ferric oxide and alumina, while the acid-soluble phosphoric acid is high. There is a small amount of acid-soluble manganese, but this element could not be detected in the exchangeable form.

The quantities of nitrogen and of organic matter are high, but the ratio of carbon to nitrogen is about normal.

The composition of the clay fraction resembles that of the clay of A.1, the ratio of silica to alumina being well below 2.

"Soil" E.1, from the Sand-dune Area, Elbow Beach.—This sample was forwarded to give an indication of the nature of the strata underlying the soils of Bermuda. It consisted of coral sand with some plant remains.

A representative portion was submitted to chemical analysis with the following results:

		Per cent.
Lime	CaO	50·50
Magnesia	MgO	3·31
Ferric oxide	Fe_2O_3	0·27
Alumina	Al_2O_3	
Titanium dioxide	TiO_2	
Manganous oxide	MnO	nil
Silica	SiO_2	nil
Phosphoric anhydride	P_2O_5	0·03
Sulphuric anhydride	SO_3	0·42
Potash	K_2O	0·05
Soda	Na_2O	0·20
Moisture at 110° C.		0·58
Combined water, carbon dioxide, organic matter		44·47

It is evident from the chemical analysis that this material consists almost entirely of calcium carbonate with a small proportion of magnesium carbonate. The remaining constituents are all very low in amount.

It appears, therefore, that the stratum underlying the soils of Bermuda will consist of soft coral limestone rock, cemented together by solution and subsequent re-deposition of calcium carbonate from the original coral sand. This accounts for the highly calcareous nature of all the samples of soil.

It is well known that some species of plants growing on a relatively pure limestone or soil derived from such a limestone are apt to suffer from chlorosis caused by excess of lime. This condition is usually very difficult to cure.

SUMMARY AND CONCLUSIONS

All these six soils are of a highly calcareous type, although the actual percentages of carbon dioxide present vary considerably. The distribution of the carbonate throughout the different fractions of the soils also varies in the different samples.

The soils do not appear to be deficient in any of the usual plant-food constituents, with the possible exception of potash, which is somewhat low in amount in most cases.

The variations in composition between soils growing healthy plants and those growing chlorotic plants are small and are not always in the same direction, so that it does not seem possible to draw any definite conclusions regarding the effect of the composition of the soil on the chlorotic condition of the plants.

Factors which are known to cause chlorosis in other plants include the following :

(1) Excess of lime ;
(2) Deficiency of magnesia ;
(3) Excessive ratio of lime to magnesia in a readily available form ;
(4) Deficiency of manganese ;
(5) Deficiency of iron, or large excess of manganese over iron, preventing the absorption of the latter.

Any of these, however, which occur in the present samples of soil, appear to be as marked in the soils growing healthy plants as in those growing chlorotic plants, and hence the analyses do not afford any indication of the reason for the chlorotic conditions prevailing in certain soils.

It is known that certain deficiency diseases of plants are markedly affected by rainfall and drainage conditions, and since it is evident that the depth and hence the drainage of the soils of Bermuda vary very considerably even in a short distance, it seems possible that the chlorotic condition of the plants may be affected more by the drainage than by the composition of the soil on which they are growing. The most likely cause of chlorosis, in conjunction with drainage, seems to be excess of lime over magnesia, in a readily available form, leading to depression of the absorption of the latter constituent by plants. It might be worth while trying small-scale experiments with the application of " kainit," a low-grade potash manure containing a considerable amount of magnesium chloride in addition to potassium chloride. The magnesium chloride is of course soluble in water, and hence would be readily available to plants, but it must not be forgotten that this solubility will also render it very easily washed out of the soil and so lost.

ARTICLES

THE MINERAL WEALTH OF INDIA ; ITS PRESENT AND FUTURE DEVELOPMENTS

(*A lecture delivered at the Imperial Institute on March 12th,* 1931, *in connection with the Exhibition of British Empire Minerals.*)

By Sir Edwin Pascoe, M.A., Sc.D., F.G.S.,

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To many people the name of India conjures up dazzling visions of gold and precious stones. The gold of Mysore has become famous, poets have sung of the diamonds of Golconda, and Burma has given its name to the pigeon-blood ruby. Yet what are the facts ? The boasted gold of Ind is now but a paltry 2 per cent. of the world's supply. The value of the diamonds recovered in the year 1929 was less than £4,000. Incidentally, never a diamond has been found within forty miles of Golconda, which was merely the mart at which the stones were sold or bartered. As for rubies and sapphires, the Burma Ruby Mines Company went into voluntary liquidation in 1925, though stones are still obtained by letting out certain gem-bearing areas on a tribute system. The value of the output of rubies and sapphires in 1929 amounted to some £13,500, that is, to about one-third of the value of the humble clay out of which the Indian builders and potters made the year's supply of bricks and water-pots.

Far be it from me to decry industries which in the past have made India famous, but the steady and more recent development of more prosaic mineral resources necessitates a readjustment of values. In doing this, moreover, we must avoid exaggeration. Unknown or incompletely explored countries have always inspired a pathetic belief in a fabulous mineral wealth, and there are still optimists who believe in vast undiscovered treasures buried in the jungle fastnesses of the Indian peninsula, in the mysterious Himalaya, or in the legendary confines of uppermost Burma. All we can say is that there are still many unprospected tracts and, therefore, still some hope of new discoveries.

If India's minerals be arranged in order corresponding to the value of their output, the first five are found to be: coal, petroleum, lead, manganese and gold. The production of coal in Great Britain—a country very little larger than either Bengal or Bihar and Orissa—is normally ten or twelve times that from the whole of India. India's contribution to the world's supply of petroleum in 1929, although a record output, was only 0·61 per cent. of the total. Even the value of her lead was no more than 5 per cent. of the world's figure. Manganese is the only one of the five minerals in whose market India holds her own, sharing with Russia the premier position as a producer. Her gold supplies have been completely eclipsed by those of South Africa.

Having disabused our minds of misleading tradition and uncalculating credulity we are now in a position to form a truer picture of India's mineral wealth and potentialities. And the true perspective is, in fact, very far from discouraging.

The most critical of all minerals are the fuels, petroleum and coal. In the former, the British Empire is lamentably lacking and contributes not more than 1½ per cent. towards the world's supply. Omitting the small oil-shale industry of Scotland and the undeveloped oil supplies of Canada, the above contribution is made almost entirely by Trinidad and India (including, of course, Burma). So far as the Empire is concerned, therefore, the oil reserves of these two countries are of considerable importance. It is true we have financial and administrative interests in the petroleum of Persia, Iraq, the Argentine, Venezuela, Ecuador, Mexico, Roumania and the United States themselves, but for war purposes, for instance, India's reserves might play a critical part. The superiority of petroleum fuel over coal is now a serious item in the preservation of our naval position. Nor is it an exaggeration to say that petrol is as necessary to the Army as fuel oil is to the Navy. I am not anxious to stress these aspects unduly, as we all hope for permanent peace, but our commercial welfare is as much concerned as our safety. Petrol, fuel oil, lubricant, kerosene, wax and tar are all required for economic purposes which I need not enumerate. In India the cheap sale of kerosene has done much to enlighten—literally and metaphorically—the uneducated classes of that country.

The position in India may be stated thus. The most important of the oilfields—Yenangyaung—has already passed its zenith and its production is maintained at its present high figure only by intensive development. Its place as the premier oilfield of Burma is being gradually taken by the less exploited Singu field, and in this way it will be possible to meet the capacity of the Rangoon refineries for many years to come. The oilfield of the north-west Punjab is capricious in its behaviour, but is expected to make a substantial addition to India's total for a considerable period in the future. The same may be said for the fields of Upper Assam, the yield from which continues to show a steady increase year by year.

In my opinion the coming world shortage of natural petroleum derived from borings will be met by two remedies, which it may interest you to consider. When a boring is sunk into an oil-sand and oil drawn up the pipe by pumping, the diminution of pressure and the removal of the lighter constituents of the oil cause a deposition of wax in the interstices of the oil-sand and a general thickening in the oil left below. The sand, in fact, becomes clogged. For this and other reasons, it is possible to extract by pumping only a certain proportion of the oil originally present in the sand. Various estimates have been made of this proportion. They vary considerably, and indeed the actual proportion must depend upon many conditions. Some of you may be surprised to learn that it is not far from the truth to assume that, on a rough average, only one-third of the total oil is raised by boring and pumping, and that no less than two-thirds remain behind in the ground. In other words, after forcing the maximum possible into the bores by compressed air and finally by suction, the greater part of the original oil-pools still remain below, and the only way to win this oil will probably be to go down and get it by ordinary mining processes. Such processes have been successfully followed in Alsace for many years past, and a proposal for a similar exploitation by sinking shafts and galleries in two of the Thayetmyo areas in Burma is actually under consideration at the present moment. Needless to say, the mining of an oil-sand can be undertaken with greater safety after the bulk of the gaseous constituents of the oil have been allowed to escape through the preliminary boring processes. The mining of oil-sands is naturally a more expensive method of obtaining the crude liquid than boring and pumping, but there is little doubt that oilfields, such as Yenangyaung and Singu, will all ultimately experience a new lease of life through mining methods.

The other remedy will, I think, be the utilisation of oil-shale. Some years ago I had occasion to examine the question of the reserves of oil-shale available in the world. The result was startling. I will not bore you with figures which, moreover, can only be of the roughest approximation, but it seemed safe to conclude that there is enough oil-shale in the world to produce at least ten times the total amount of natural well petroleum obtained since petroleum became a commodity of commercial importance!

The two remedies I have just outlined will probably come in gradually side by side, as the market price of petroleum products rises. The production of oil by the hydrogenation of coal is another alternative which may, at a later period, play a conspicuous part in the world's petroleum market. The ultimate substitute will be some form of vegetable oil or alcohol, but this substitution, on any but a negligible scale, may be looked upon as many generations ahead. In the light of the facts I have just laid before you any talk of a coming shortage in petroleum seems uncalled for and ridiculous. Shortage of *cheap* petroleum—shortage of *inexpensively won* petroleum from flowing and pumped wells—there will undoubtedly be, and the present generation may well see the beginning of it if the modern craze for speed and mechanisation continues. As these supplies decrease, prices will gradually rise and bring in mined oil and the vast stores of oil-shale as competitors.

Oil-shale is known to exist in commercial quantities in the Amherst district of Lower Burma. Our knowledge of these deposits is incomplete, but they may be of considerable size and importance ; at present they cannot compete with any great success with natural petroleum.

The United States, of course, dominates the petroleum situation and in 1929 supplied the world with 67 per cent. of its requirements. Let me give you an illustration of the scale of this predominance. During the twelve months of 1927 the United States had occasion to increase her output of petroleum to meet an extra demand ; this *increase* was greater than the *total production* of India throughout the past sixteen years ! The United States is also blessed with most of the world's oil-shale, so that this predominance is likely to continue. The United States Government is setting a wise example by adopting a conservative policy, and by discouraging a rapid exploitation of the natural petroleum supplies.

With regard to coal, it is only possible for me to summarise a few of the critical facts. India possesses large reserves of coal, the latest estimate—a conservative one—being over 36,000 million tons. Something like four-fifths of this, however, lies too deep to be raised with profit under conditions as they are to-day, and only about 7 per cent. of it can be described as first-grade coking coal ; most of the latter comes from Bihar and Orissa. In brief, there are large reserves of second-grade coal, little of which can be remuneratively worked, and an amount of first-class coking coal insufficient for the future requirements of the country's iron and steel industry. The construction of canals between the coalfields and their markets would facilitate and cheapen distribution, and might make it economical to work more of the second-class coal.

Something like 98 per cent. of the coal output of India is consumed within the country itself, so that most of the coal problems are domestic ones. As in most countries, the coal trade of India has been suffering from over-production—or under-consumption—whichever you like to call it—but there is every hope of higher prices in the early future. The Indian railways collectively form the greatest consumer, but the iron and steel industry is not far behind and is demanding larger and larger amounts year by year.

The largest of the fields, that of Jharia, is now suffering seriously from fires in the mines caused by the collapse of the roof on the removal of pillars. Large quantities of first-class coal are now standing in such pillars formed by the intersection of galleries in the Jharia mines, and its remunerative removal is one of the problems now facing the companies concerned. It is thought by many that organised sand-stowing on a large scale, with sand from the Damuda River, would go far to solve this difficulty. For the benefit of non-mining members of my audience I may perhaps explain that sand-stowing is the replacement of the coal with sand, step by step, as the latter is extracted from the mine; in this way a collapse of the roof of the coal-seam is avoided, and a maximum quantity of coal extracted.

The crumbling Tertiary coal of Assam provides another problem. There are in upper Assam very large quantities of this coal, which has an ash percentage as low as 1·6 and which yields a coke of excellent hardness. Unfortunately this coal contains nearly 2½ per cent. of sulphur, the presence of which in the coke renders the latter unsuitable for metallurgical purposes.

A still more important problem is the prevention of the use of dried cow-dung as a domestic fuel. The burning of this valuable manure, of which the country is desperately in need, is an evil the prevention of which would not only confer great agricultural benefit, but should open up an expanding market for soft coke or any kind of smokeless fuel as a substitute. The immense possibilities of a smokeless-fuel industry will be more apparent when I tell you that out of a population of some 320 millions, the consumption of coal and soft coke for domestic purposes is only about 2 million tons per annum (14 lb. per head per annum !) Dried cow-dung is being sold in India as a fuel, often for less than half its value as a manure, and to persuade and help the poor farmer to put the cow-dung back on the land and buy coke in its stead would be a patriotic as well as a lucrative occupation. Another difficulty confronting the coke industry in India is the absence of a market for the gas which is produced simultaneously with the coke. In this country, as you know, there is as much demand for the gas as for the coke, and innumerable towns within reach to furnish a double market. In India, even in the largest cities, such as Calcutta or Bombay, the demand for gas is extremely limited.

Next to the fuels in importance I would place the iron ore deposits of Bihar and Orissa and elsewhere, in spite of the fact that in our list of minerals arranged in order of the value of their outputs iron ore stands eleventh. The people of India had acquired a fame for metallurgical skill many centuries ago and the celebrated *wootz* steel made its reputation long before the Christian era. Attempts to introduce European methods were first made in Madras about 1830, but it is in the district of Bihar and Orissa and the adjoining feudatory States that are found hill-ranges of almost solid hæmatite, much of it consisting of ore containing 60 per cent. of iron and over. The latest conservative estimate of 3,000 million tons of ore is about three-quarters of the known reserves in the Lake Superior area of North America, which is at present the most productive iron field in the world. This is a very rough comparison and may have to be modified in the light of future development. Not only is the Indian estimate likely to be increased but also that of the United States. Owing to a somewhat short-sighted regulation, all proved reserves of ore in the latter country are subject to a tax, with the result that mining firms take care to prove no more than their early requirements, and there is still a large element of guess-work in the figures for the United States' reserves.

In iron and steel, India's potentialities are those of a first-rank producer, but the industry is still in its infancy. Ten years ago some of the hill ranges now being worked were covered with virgin jungle. The last time I crossed one of them I was tracking *sambhar* and met a tiger who was doing the same. The principal problems which confront the iron and steel industry in India are : (1) the conservation of the limited resources of hard coke, (2) the invention or modification of a process for smelting iron ore without the use of hard coke, and (3) competition. Some years ago the Government of India came to the conclusion that any restriction on the use of first-class coking coal for other than metallurgical purposes would be an act of unjustifiable autocracy and an unfair contravention of the claims of other important industries, including the railways. It is in any case for the iron and steel industry to make and justify proposals having this end in view. Incidentally it is possible by hydrogenation to convert most non-coking coals into coals capable of yielding a hard metallurgical coke ; this process has not yet passed from the experimental stage, but the recent Imperial Economic Conference in London found that it is nearer commercial importance than many imagine. With regard to the second problem, iron ore can be smelted with ease in the laboratory without the use of hard coke. Several commercial processes by which such a change can be effected on a large scale have been invented, and there is no reason why one or more of these should not eventually solve the difficulty in India. Any process requiring a finely-ground ore—and the probabilities are that fine-grinding will be an essential condition—will be suitable, since large quantities of the Indian hæmatite consist of a very fine natural dust which, under present blast-furnace practice, must be balled before it can be smelted with coke. Competition is at present being fought with the unsatisfactory weapon of tariffs. A labour force of some size is employed and the largest of the three principal companies, the Tata Iron & Steel Co., have their own town, Jamshedpur, with a population of over 100,000 souls.

We now come to manganese, the value of whose output is between five and six times that of India's iron ore. Manganese, as you know, is one of the hardening constituents of steel, and the industry is consequently bound up closely with that of iron and steel. Many thousands of tons are used annually in the electrical industry, and considerable quantities in paint-making, calico-printing and dyeing, porcelain and brick-glazing, the fluxing of silver and copper ores, the decolorisation of glass, the preparation of disinfectants and chemicals and, recently, as an agricultural fertiliser. In spite of these numerous uses the potential production of manganese is nearly everywhere in excess of consumption. Of the thirty-five countries in the world producing manganese, India heads the list and contributes one-third of the total output. Russia comes next with about 25 per cent. The comparatively new Gold Coast deposits are responsible for 12 or 13 per cent., and our old rival Brazil for nearly 11 per cent.

The greater part of the Indian ore, most of which comes from the Central Provinces, is of a high grade, averaging nearly 52 per cent. of the metal. The country has now been well prospected for this mineral, and fresh discoveries of any large importance are improbable. The recently discovered laterite ores in the Mergui Archipelago of southernmost Burma promise to be extensive in bulk; their advantageous location should do much to balance any inferiority in grade. The problems confronting this industry in India are competition, freight and the vagaries of the steel industry. The opening of the new harbour at Vizagapatam should do much to assuage the transport difficulty.

The world's position in manganese is an interesting one. Up to the outbreak of the war, Russia was the chief producer of this mineral. During the war her activities declined and, in fact, soon ceased except in Georgia. The United States, deprived entirely of her Russian supplies and restricted to less than half of her usual imports from India, had recourse to Brazil, whose exports in consequence increased sevenfold during the war. The exports from Brazil to the United States maintained a high figure up to and including 1922, since when there has been a marked but capricious decline. India's attempt to regain the United States' markets was handicapped by the re-entry of Russia as a serious competitor in 1924, and exports from the latter country to the United States have now regained their pre-war values.

I do not wish to bore you with too many figures, but the production of manganese in India rose in 1927 to the highest yet recorded amount of nearly 1,130,000 tons, accompanied by a rise in value to the peak figure of nearly £2,850,000, f.o.b. Indian ports; this upward tendency, however, has not been maintained. The competitive threat from Russia is a serious one but rests upon unstable foundations. The extraction of the ore is now under Soviet management, and costs can be made very small even in face of reduced efficiency. The Russian miners are paid in paper money, and the Soviet can afford to sell at a figure little more than that covering the carriage from the Black Sea to the consumer. The position is to some extent controlled by the inferiority of the Russian ore, which requires considerable washing treatment before material suitable for metallurgical uses is produced. The dusty Russian ore is, in fact, more suitable for chemical and electrical purposes, and for metallurgical use is inferior to the Indian material. A more serious rival in the early future will probably be the South African deposits, which are of high grade and extensive. From an Empire point of view this is consoling.

A small quantity of ferro-manganese is manufactured, but it is regrettable that most of India's exports consist of ore in the raw state. There is now a steady consumption of manganese at the works of the three principal iron and steel companies in India, not only in the steel furnaces of the Tata Iron & Steel Co. and for the manufacture of ferro-manganese, but also for addition to the blast furnace charge in the manufacture of pig iron.

From manganese to magnesite is a phonetically easy change, and we are again dealing with an industry bound up with that of iron and steel. In the Salem district of Madras there are deposits of magnesite which, from a practical point of view, may be looked upon as almost unlimited. The mineral is won by open quarrying operations, and is calcined on the spot to produce the two kinds of domestic commodity, calcined or caustic magnesia and dead-burnt or sintered magnesia. These products have three principal applications :

(i) as a refractory material for the lining of metallurgical furnaces ;
(ii) for use in the preparation of the so-called " oxy-chloride " cements employed in the manufacture of artificial stone ;
(iii) in the manufacture of carbon dioxide.

The principal use of magnesite is for metallurgical purposes, for which the dead-burnt form is required, and something like 90 per cent. of the world's total output is employed for this purpose. The chief competing sources of supply are Austria, the United States and Greece. The Indian material is more suitable for the preparation of oxy-chloride cement than for the lining of metallurgical furnaces on account of the paucity of its iron content. In this way it approaches closer to the Grecian than to the Austrian type. During the war, however, ferric oxide was added to the Indian magnesite in order to produce a dead-burnt commodity suitable for furnace linings. Greece produces more caustic magnesia than any country, excluding the United States, and her output is consumed mainly in Europe.

All this will prepare you for the statement that the world's supplies are, under present conditions, far greater than the demand is, or is ever likely to be. There is no really large market for magnesite, and producers have to obtain what prices they can. A demand in India itself for artificial stone products would stimulate an industry capable of large expansion.

Chromite is another mineral closely connected with the iron and steel industry. It has shown a remarkable progress in its industrial application since the war. It is employed in the manufacture of special steels, as a refractory lining for smelting furnaces, in the preparation of chromates and bichromates, in chromium plating, and for several other purposes. An immense impetus was given during the war to this industry in India. The raisings now total some 50,000 tons a year, most of it coming from Mysore State and the Zhob Valley of Baluchistan. The bulk of the exports go to the United Kingdom. The small output from the Singhbhum district is absorbed by the Tata Iron & Steel Co.

Another mineral subordinate to the steel industry is wolfram, the tungstate of iron and manganese. Tungsten has the peculiarly useful property of enabling a steel with which it has been mixed to maintain its hardness at high temperatures. It is, therefore, in particular request for high-speed tools, the steel of which contains other hardening metals, such as chromium and vanadium. Ordinary carbon-steel tools begin to lose their hardness at 500° F., whereas tungsten steel remains hard and sharp up to 1,150° F. A recently discovered steel alloy containing cobalt as well as tungsten is said to be capable of cutting glass, porcelain and even quartz. Tungsten is also used for electric lamp filaments, permanent magnets, the valves of internal combustion engines, gramophone needles and other purposes, but the bulk of production is absorbed by the steel industry. The discovery of tungsten steel has revolutionised the machine-shop practice of the world, and an American writer has gone so far as to say that to deprive a nation of tungsten is to cripple both its military and industrial powers. During the war all tungsten ore raised within the British Empire was appropriated for use in the United Kingdom, and it would not be too much to say that the wolfram of Tavoy in southernmost Burma was a prominent factor in winning the war. China is a formidable rival in this mineral, which in lower Burma has now become but a by-product to the sister mineral, tin.

The silver, lead and zinc mine of Bawdwin in Upper Burma is one of the richest in the world. The ores, consisting of the sulphides of these metals, are associated with an ancient series of volcanic ashes, breccias and lava flows, and occur along a zone of overthrust faulting. A steady yield of copper is now being obtained from this mine, together with small quantities of nickel, antimony and cobalt. The Chinese worked these rich deposits from early in the fourteenth to the middle of the eighteenth centuries, but were only interested in the silver ; in fact their discarded slags were for years made use of by the company now operating. A gratifying feature in the recent progress of Bawdwin is the utilisation of the zinc sulphide which in the old days used to be burnt off and wasted.

There is room for more than one sister industry in connection with these lead and zinc deposits. Manufactured lead and zinc articles, for instance, are still being imported into India, instead of being made on the spot, and no diminution of the imports of the pigments, red and white lead, has followed the development of the Bawdwin mine. What is more deplorable still is the loss of the sulphur from the ores. This either leaves the country in the exported concentrates or is burnt off at the mine. One of India's great needs is an indigenous sulphuric acid supply. Some years ago a scheme was put forward by which the Bawdwin zinc concentrates were to be brought over to India and their sulphur contents made use of for the manufacture of sulphuric acid in a plant at Jamshedpur. Most unfortunately the scheme fell through, and the sulphur which India needs so badly is at present being exported in the form of zinc concentrates to Belgium. Large quantities of sulphur are also being burned off from the lead sulphide in the same area. The sulphuric acid now manufactured in India is nearly all being made from imported sulphur.

The ruby mica of India has achieved a world-wide reputation and the mines of Kodarma and Nellore are responsible for something like 65 per cent. of the world's supply of sheet mica. A semi-artificial product known as micanite is produced by combining together " splittings " with the help of shellac. It is in the preparation of these splittings that Indian labour, consisting of women and children, excels. The bulk of the exports of mica go to the United Kingdom. The importance of mica has grown with the electrical industry, in which its flexibility, toughness and resistance to heat give it a unique position as a non-conductor. Several artificial substitutes for mica have been placed on the market, but so far none of them is likely to be a serious rival to the natural mineral. Incidentally there are at least two by-products in Indian mica mining on which small industries might be based.

The mica is obtained from a coarse pegmatite, another of whose constituents is potash felspar. Potash is a valuable agricultural fertiliser, and there would seem to be an opening for a small subsidiary industry by hand-picking the felspar from the mica dumps, and perhaps transforming it by fusion with lime and other substances into a more soluble form. Another possible by-product is beryl, which is required for the preparation of the beryllium alloys. The market price for beryl within the last two years has been as high as 200 dollars a metric ton.

There is no time for more than a reference to the copper mining of Bihar and the tin of Tavoy and Mergui in Lower Burma. India is a large consumer of copper in the form of brass, and her indigenous reserves, so far as they are known, would not supply her needs for more than five or six years. Most of the Burmese tin concentrates find their way to the Straits Settlements, the tin-smelting centre of the world.

As a source of aluminium, bauxite has been a disappointment in India and most of the ore produced is used in the manufacture of cement or in the refining of petroleum. The cement produced with the help of bauxite is a quick-setting cement, which is superior to Portland cement in its resistance to the action of sea-water. In petroleum refining it is the colloidal properties of freshly ignited bauxite that make it useful in decolorisation and desulphurisation.

India possesses valuable deposits of sillimanite and kyanite, two minerals which form ideal refractories for furnace linings, etc. The development of these deposits, which occur in Assam and Bihar, has not yet passed the initial stage.

I have already alluded to gold. The Indian output is now exceeded by that of Japan, including Cho-sen. The interesting features of the Kolar mines, which are the only ones at present being worked in India, are the persistent richness of the reef with depth, and the ease with which the ore yields up its gold. The Champion Reef and Ooregum mines are each of them well over 1¼ miles deep. The temperature at these enormous depths is 120° F. or even greater, and ventilation is an extremely difficult problem. A regrettable feature is the frequency of dangerous rock-bursts, caused by the strain set up in the roofs and walls of the galleries at this great depth. The working population on the Kolar gold-field numbers some 19,000 souls.

The monazite of Travancore has lost its market owing to the replacement of incandescent gas mantles by electric light. With the monazite sand are collected the minerals, ilmenite and zircon, which were formerly regarded as by-products to monazite. Positions are now reversed, and it is the monazite which is a by-product to the ilmenite. Ilmenite is a valuable raw material for pigments, especially for a white paint which has twice the covering power of white lead. Zircon is a highly refractory mineral and is employed for the making of crucibles and high-temperature cements.

A fortune lies before the man who can create a larger demand for gypsum. There is abundance of this mineral in India, where, as elsewhere, the output is restricted by the demand. Its present uses are chiefly for the manufacture of plaster of Paris and as a fertiliser on the soil.

We must leave the rest of India's minerals with a bare enumeration : the salt mines of the Punjab, and the salt recovery of the Sambhar Lake, Bombay, and elsewhere ; the old saltpetre industry, which was set on its feet by the American Civil War ; the valuable building materials and road metal ; the materials for cement-making, a manufacture which has made a great advance in recent years ; steatite, so much in demand by high-caste Hindus for cooking pots ; asbestos, disappointing in its brittleness ; the jade-stone of Upper Burma, beloved of the Chinese ; pottery clay and fullers' earth ; red and yellow ochre used in paint-making ; barytes ; agate ; amber ; alum ; corundum ; and a few others.

In the successful development of a country's mineral resources, a factor of prime importance is a set of sound mining rules. India is fortunate in this respect, and her mineral industry has flourished under rules drawn up or remodelled by an officer of the Geological Survey who combined the qualities of scientist, administrator and statesman to an unusual degree. India's debt to Sir

Thomas Holland in this connection is one which posterity alone will adequately realise. Our aim has always been to encourage private geological investigation and prospecting by ensuring, as far as possible, to an investigator his right to exploit any discovery he may make, provided, of course, that he is a man of good repute and has, or can command, the capital for development.

In following what I have been trying to say, you will, perhaps, have noticed that India is unusually well supplied with the munitions of war. She possesses most of the many constituents requisite in the manufacture of all kinds of steel ; petrol and coal as fuels for transport ; oil for the lubrication of vehicles and guns ; lead and nickel for bullets ; saltpetre for gunpowder ; mica, so much in request for the electrical parts of aeroplanes ; tin for commissariat uses. The only important war minerals she does not actually produce are sulphur and aluminium, and these she possesses potentially in large quantities.

With regard to the future, the iron and steel industry, in the right hands, should become the pivot of a great industrial advance, and the development of many other minerals would no doubt increase *pari passu.* At the same time there is such a thing as a too intensive exploitation of a country's mineral resources. They are assets, it is true, which should be utilised to the full, but they are wasting assets which cannot be replaced, and many of them may increase considerably in value as world supplies become exhausted. More especially they give rise to multitudinous co-ordinate and subordinate industries, to which it is obviously advantageous to give as long and steady a life as possible. Very often conservation pays in the end, and to use other people's raw materials to develop domestic industries seems a better policy than the converse—always supposing that other people are agreeable ! A rational and elastic mean between stagnation and intensive depletion is what is required. The vital points are to extract every possible ounce of a deposit out of the ground, and to establish as many sister industries as possible without delay. In India the establishment of such industries has never been as spontaneous as it ought.

There is in fact room for reform in many directions as soon as the political situation makes it possible.

Surely it is wrong that the concentrates of zinc sulphide from Bawdwin should be shipped to Belgium for smelting and the zinc and sulphur imported back again separately. Where is the red and white lead industry which one would expect to find in collaboration with this mine? Why should it be necessary to import annually even the small quantity of 2,400 tons of lead in the form of manufactured articles? Why is the soft coke industry so insignificant? Why is most of the manganese ore exported in the raw state instead of in the form of ferro-manganese? Would competition with the Malay States make it impossible to smelt the tin of Tavoy and Mergui on the spot and ship it from almost adjacent harbours? Why is a valuable manure like saltpetre exported to increase the tea crop of Ceylon or to amuse other nations with fireworks? The glass industry is expanding, but India's daughters still spend some £850,000 each year on imported glass bangles and beads, although there are adequate supplies of sand suitable for glass-making in the country itself. Is it right that the annual value of the imports of glass-ware exceeds £1,800,000, and that more than half of it should come from Japan and Czecho-Slovakia? How long will it be before India ceases to import steel articles and begins to supply the world with the same instead? How long will it be before this industry absorbs more of the Indian chromite, tungsten, manganese and perhaps magnesite? Is the transport question the critical factor in making it cheaper to import annually £58,000 worth of Italian and Grecian marble instead of buying equally beautiful material in Rajputana, or is it the more systematic organisation of the European quarrying operations? Is not the manufacture of paints capable of expansion? Will agriculturists awake soon to the value of the extensive phosphate deposits in Bihar and in Trichinopoli, which, in face of the present low demand, it scarcely pays to work?

These are some of the questions which will confront the new India, and I venture to think that the closer the contact between her and other members of the Empire, the more able will she be to answer them. It is institutions like this great Imperial Institute which make such contact possible and profitable. Surely it would be a pity to forget that fact in the stress of political change and economic depression. " Rationalisation " is now the cry in every hard-pressed industry, and rationalisation on an Empire scale is one of the aims of the Imperial Institute.

DEPRECIATION OF PREPARED COPRA DUE TO MOULDS AND INSECTS

By F. R. Passmore

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In the course of investigations into the biological deterioration of stored cacao carried out in the Stored Products Research Laboratories of the Imperial College of Science and Technology, the suggestion arose that the organisms attacking copra were of such a similar nature as to warrant a survey of that product being undertaken concurrently.

In order to ascertain the extent of the loss to the industry caused by insects and mould growths upon copra during the period between the preparation of the copra and the manufacture of oil from it, and to determine whether a detailed biological survey would be justified, preliminary enquiries were made of manufacturers, shippers, and others engaged in the transport, sale, exchange and storage of copra in this country.

The aim of the proposed survey was to assist the industry by a study of :

(i) The insects infesting copra, with a view to their control ;

(ii) The relationship (if any) between insect infestation and fungal development ;

(iii) The physiological effects of the moulds growing on copra, and their prevention.

Of the four largest manufacturing firms interviewed, three expressed themselves indifferent to such investigations and gave the following reasons.

(1) There is sufficient good-quality copra produced to meet their requirements.

(2) No large stocks which might deteriorate after purchase are kept in England.

(3) Manufacturers pay for delivered weight only.

(4) If copra is not up to standard an allowance is claimed by arbitration, whereas, should it be above standard, no more than the agreed price can be demanded by the seller.

The exception was a firm of oil crushers who buy South Sea copra exclusively. This class of produce is generally of a comparatively low standard and the expressed oil must often be subjected to expensive refining processes to eliminate free fatty acids, smell and discoloration in order to render the oil fit for edible purposes.

Oil from top-grade copra needs less refining than low-grade oil, and whether the higher refining costs of low-grade oil are balanced by the lower price is problematical. Refining costs are difficult to determine owing to the time and trouble involved in the process. Clean, dry copra is wanted, of a high oil content and free from mould.

Representatives of shipping firms engaged in the copra trade of the South Seas also would welcome any investigations which might lead to the betterment of this produce; the premium for good copra is small but the price of all copra is so low that it is felt that efforts to improve the lower grades are worth while, provided no great expense is entailed. They state that much damage is caused by insects during shipment, but by arrangement with the seller they themselves are usually covered against actual loss of weight.

Copra from the South Seas, that is from Australia, New Zealand, Papua, Nauru, W. Samoa, Fiji, New Britain, and other islands in the Pacific, formed 32 per cent. of the total imports of copra into the United Kingdom in 1928, and comprised 44 per cent. of the total imports of copra from British possessions; in 1929, the corresponding figures were 42 per cent. and 58 per cent. It will be seen from the appended list of copra grades that Samoan and Rabaul copras are quoted separately and above the rest of South Sea, which is due to recent co-operative effort on the part of the local producers: the bulk of South

Sea copra is still recognised on the home market as being of the lowest quality.

In a paper reviewing the copra market (October, 1929) the Agricultural Economist of Malaya (4) points out that owing to the prices of the different grades of copra being based upon the *average standard* exported from the country of origin no advantage is likely to be gained by any single producer who, probably at considerable expense, succeeds in improving the quality of his individual output. It would seem that while the present system of marketing obtains, the only method of improving the quality of a country's produce and thus raising the market price of its standard is by some system of enforced produce inspection such as that which is giving good results in Samoa.

Insect Infestation of Copra

Apart from the loss by actual consumption which, judging from the hordes of insects seen in inspected shipments, must be considerable during a long voyage, the main objection to the presence of insects is the production of " dust." Dust is the commercial term generally applied to the small broken pieces of copra and extraneous matter in a sample, and its presence is a common cause of arbitration for price adjustment. Insects or the traces of insects were found in every sample inspected by the writer.

De Fremery (3) reports that a case of copra opened at Amsterdam was found to be infested by *Silvanus surinamensis* L., *Tribolium castaneum* Hbst., and *Necrobia rufipes* De G., over 95 per cent. of the insects being *S. surinamensis*. " Examination of the material led to the conclusion that this beetle prefers copra of which the cell structure has been broken down. Cell degeneration is probably the result of the occurrence of bacteria at the time the copra is dried, so that the preparation of the product is a factor of great importance as regards its susceptibility to attack by pests."

From the appended details of twenty samples examined it will be seen that *Necrobia rufipes* was the most prevalent pest encountered. It is mainly to combat this beetle, which is known in the trade as the " copra bug," that experiments have recently been carried out by the manufacturers of a sulphur dioxide fumigation appliance to determine whether sulphurous fumigation of prepared copra would result in the increased acidity of the product. The results were reported to be satisfactory and the importing firm, upon whose behalf the tests were made, propose instituting regular fumigation of copra stocks at the collecting ports immediately prior to shipment.

The insects found in copra during the preliminary survey were :—

(1) *Necrobia rufipes*	three most prevalent.
(2) *Oryzaephilus* (*Silvanus*) *mercator*	
(3) *Tribolium castaneum*	
(4) *Carpophilus flavipes*	more occasional.
(5) *Alphitobius diaperinus*	
(6) *Ahasuerus advena*	
(7) *Laemophloeus turcicus*	
(8) *Dermestes cadaverinus*	

Deterioration of Copra caused by Moulds

Walker's (5) investigations prove that rancidity of coconut oil is mainly due to fungi and that, owing to insufficient moisture, bacterial action is not important in this respect. Copra containing less than 20 per cent. of water is practically free from bacterial action.

If copra is properly prepared in the first place, that is, if it is dried out to six or seven per cent. moisture content, it is safe from mould attack as long as it is kept dry. The main causes of deterioration are :

(1) Storage of the coconut meat before preparation, when it is vulnerable to micro-organic action ;

(2) Insufficient drying during preparation leaving a moisture content capable of sustaining mould growth ;

(3) Inefficient "country storage" after drying when copra is unprotected from the rain.

Experiments carried out upon a quantity of copra stored under normal conditions on the ground floor of a London riverside warehouse, one side of which was open to the wharf, showed that in seven months the moisture content of copra in six bags was altered from :

5%, 5%, 7%, 7%, 9%, 9%,
to 5·4%, 5·5%, 5·6%, 5·8%, 5·3%, and 5·7%,

respectively. Humidity records taken in the immediate vicinity of the copra showed an average relative humidity of 84·6 throughout the whole period of storage, March to October, 1930. The copra was free from moulds when placed in the store and remained entirely unattacked until disposed of in October.

This bears out the conclusions reached by Brill, Parker, and Yates (2) that copra once dried to about 6 per cent. water content does not absorb sufficient moisture to support even a superficial mould growth unless kept in a saturated atmosphere for a prolonged period, and that copra stored in the open will lose or gain water until it is in equilibrium with the atmosphere. Equilibrium point is stated to be about 5 per cent. moisture content under normal climatic conditions.

In the same paper is a discussion of the moulds most frequently found in Philippine copra, and a list is given as follows, in order of their moisture content requirements.

Aspergillus niger van Teigh, occurs on copra with a high water content, 12 to 20 per cent.

Aspergillus flavus Link., most common, 7 to 8 per cent.

Penicillium spp., common on copra which is comparatively dry, 5 to 7 per cent.

Rhizopus spp., occur only on fresh meat and do not concern the present enquiry.

A series of experiments has recently been carried out by Mr. J. H. Eyre at the Imperial College Biological Field Station at Slough, to determine the fat-splitting properties of the most prevalent organisms found growing on copra, the results of which, it is hoped, will be published shortly.

The physiological effects of mould growth upon copra are also discussed by the Government Chemist of Fiji in the *Fiji Journal of Agriculture* (1). An account is included in the paper of experiments carried out to ascertain the actual loss of copra through fungal development under various conditions. The experiment in which circumstances were similar to those prevailing during the commercial preparation of copra in the Islands showed in fourteen days a loss of 12 per cent. anhydrous copra with an increase of acidity of 8·3 per cent.

Moulds Isolated from Copra in England

Cultures taken from copra samples from widely different sources during the course of twelve months gave rise to the following organisms :—

Aspergillus niger, flavus, tamari and *chevalieri ;*
Rhizopus nigricans ;
Scopulariopsis sp.
Syncephalastrum, probably *cinereum ;*
Penicillium candido-fulvum Dierckx and other spp. ;
Mucor racemosus ;
Yeasts.

It would be extremely difficult to arrive at any satisfactory representative figures which would illustrate the relative proportion in which these different moulds attack the commercial product by its examination in this country. Owing to the hygroscopic properties and low " moisture-content equivalent " already mentioned, cargoes loaded in a damp and mouldy condition have dried out sufficiently before reaching Europe to render the moulds inactive.

Contemporary and subsequent insect and mite infestation destroys a large amount of the dried mycelium ; " sweating," consequent upon the drying out of the copra in the holds, and such violent movements as are attendant upon unloading, reduce mould colonies to a mere discoloration of the produce.

In the course of conversations with people engaged in the manufacture of coconut oil, no endorsement has been heard of the suggestion that the presence of mould growths in any form on copra is helpful to the expression or extraction of the oil. British manufacturers who require coconut oil mainly for edible purposes want their copra clean and dry with a high oil content and of as low acidity as possible. In southern Europe where coconut oil is used for such purposes as low-grade soap making, it seems that a high oil content is the only factor demanded.

Summary

Whilst in nearly all copras there is some depreciation caused by insects and moulds, the opinion in the trade is, that only in South Sea produce is the loss serious enough to warrant biological investigation.

Cases of inferior quality can always be traced to causes in the country of origin—except in such rare instances as "sea damaged." Any improvement which is to be brought about must be wrought at that end.

STANDARD COPRA GRADES. IN ORDER OF MARKET VALUE.

F.M.G.W.S.	Malabar.	
F.M.S.	Ceylon.	
F.M.S.	Seychelles.	
F.M.S.	Mauritius.	
F.M.S.	Jamaica	or F.M.S., West Indian. Jamaica slightly better than other two grades.
F.M.S.	Trinidad	
F.M.S.	Demarara	
F.M.S.	West African (Lome, Gold Coast, etc.).	
F.M.S.	Mozambique Plantation.	
F.M. Hot Air Dried	(Crown Estates) Samoan Plantation.	
F.M.S.	Java.	
F.M.S.	Straits.	
F.M.S.	Dutch East Indies.	
F.M.	Galle.	
F.M. Hot Air Dried	Samoan Plantation.	
F.M.S.	Samoan Plantation.	
F.M.S. Standard	Samoan (new grade).	
F.M.S.	Mozambique.	
F.M. Hot Air Dried	Rabaul Plantation.	
F.M.S.	Rabaul Plantation.	
F.M.S.	Papuan Plantation.	
F.M.S.	South Sea Plantation (or Fiji Plantation).	
F.M.S.	Samoan.	
F.M.S.	Rabaul.	
F.M.S.	Papuan.	
F.M.S.	South Sea (or Fiji, or Tonga, etc.).	
F.M.	Straits.	
F.M. Mixed	Dutch East Indies (Padang excluded).	
F.M.S.	Zanzibar.	
F.M.S.	Philippine (or Manila, or Cebu).	
F.M.	Philippine.	
F.M.S. Trade	South Sea.	
F.M. Mixed	South Sea.	
F.M. Kiln-dried	South Sea.	
F.M.	Zanzibar.	

F.M.G.W.S. means	Fair Merchantable Good White Sun-dried.
F.M.S. ,,	Fair Merchantable Sun-dried.
F.M. ,,	Fair Merchantable (i.e. not necessarily sun-dried, therefore mainly kiln-dried).
F.M. Mixed ,,	Fair Merchantable Mixed (i.e. sun-dried and kiln-dried proportionately, but not necessarily 50 : 50).

Sample No.	Grade and country of origin.	No. of bags.	Dust.	Colour.	Smell.	Infestation.	
						Insects.	Moulds.
1	F.M.S. Plantation, Fiji	1,500	Much	Dark	Sour	Badly infected *Necrobia rufipes* adult and larvæ. *Silvanus* probably secondary.	Majority of pieces bear signs of growth. Small amount living.
2	F.M.S., West Indian	212	Very small amount	White	Sweet and fresh	Several *Necrobia* adults. No other visible. Moderately badly attacked.	Small number of pieces with green and brown living moulds.
3	F.M. Mixed, D.E.I. (No Padang)	139	Moderate amount	Medium brown	Slightly cooked	Badly attacked. *Necrobia rufipes* adults and larvæ.	No living moulds seen.
4	F.M.S. Plantation, Fiji	1,133	Small amount	do.	do.	Moderately badly attacked. *Necrobia* adult and larvæ. Also *Silvanus mercator* L. P. and A.	No living moulds seen.
6	F.M.S. Mixed, D.E.I. (No Padang)	550	Much	Dark brown	Sour	One *Dermestes cadaverinus*; badly attacked by *Necrobia*.	Badly moulded but very small amount living moulds.
7	F.M.S., West Indian	668	Nil	White	Fresh and good	Moderately attacked. Many specimens *Silvanus mercator*.	Few pieces growing green mould.
7	F.M.S. Plantation, Fiji	1,580	Moderate	Dark	Burnt	Moderately infested *N. rufipes*. No other spp. visible.	Copra very dry. None.
8	Plantation South Sea, Papuan	521	Moderate	Fairly good	Slightly rancid	*Necrobia rufipes* larvæ. Moderately badly infested. No adults seen.	Very badly damaged. No living mould seen.
9	do.	370	Above average	Fairly good	Slightly over-dried	Attack moderately bad. No live larvæ or adults seen.	Fairly badly damaged, apparently no mould growing.
10	Hot Air Dried Plantation, Rabaul	1,751	Good	White	Good	*Necrobia rufipes* adults and larvæ, also *Silvanus* adult. Moderately badly attacked.	Slight.

11	F.M.S., West Indian	201	Small	Fair	Strong, good	Attack slight. No adult *Necrobia* or *Silvanus*; adults *Cryptophagus*.	Very slightly attacked. Some brown mould growing, probably *Aspergillus flavus*.
12	F.M. Mixed, D.E.I. (No Padang)	113	Medium	Very dark	Burnt	Attack slight, 1 specimen *Laemophlocus*, 1 specimen *Tribolium castaneum*.	Very slight. No growing mould seen.
13	F.M.S. Straits, Singapore	802	Good	Good	Good	Very slight, *Silvanus* and *Necrobia*.	Very slight.
14	F.M. Mixed, D.E.I. (No Padang)	796	Small amount	Dark	Burnt	Moderately bad. *N. rufipes*, *Tribolium castaneum*.	Few pieces green mould, probably *Penicillium*, spp. Copra very dry except numerous immature pieces.
15	F.M. Mixed, D.E.I. (No Padang)	558	Very small amount	Light brown	Good	Moderately bad. *N. rufipes*, *Tribolium castaneum*.	do.
16	do.	506	Small amount	Light brown	Good	Moderately bad. *N. rufipes*, *T. castaneum*, *Silvanus mercator*.	Ditto, with amount of matted mycelium infested with insects.
17	F.M.S., South Sea	1,870	Medium amount	Light brown	Fairly good	Badly infested. *N. rufipes*, *Silvanus mercator*.	Small amount mouldy. No living growths.
18	F.M. Mixed, D.E.I. (No Padang)	113	Small amount	Dark brown	Burnt	Moderately bad. *Necrobia rufipes*, *Silvanus mercator*.	Small number of pieces with black mould apparently growing, probably dried *Aspergillus niger*.
19	Plantation, South Sea	1,085	Much	Light colour	Fairly good	Bad. *N. rufipes*, *Silvanus mercator*.	Traces of considerable moulding by a black mould, none living.
20	F.M. Mixed, D.E.I. (No Padang)	86	Moderate amount	Varying dark brown to light brown		Moderately bad. *N. rufipes*, *Silvanus mercator*.	do.

For this reason and because copra transported under commercial conditions offers poor scope for mycological investigation, plans for a detailed survey are in abeyance in favour of co-operation with workers in the countries of production.

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Note.—The writer is indebted to Mr. R. H. Bunting and to Mr. C. Potter, both of the Imperial College of Science and Technology, for assistance in the determination of moulds and insects.

NOTES

Algin.—The following notes on the preparation and uses of algin were compiled recently in response to an enquiry received at the Imperial Institute.

Commercial algin is the sodium compound (sodium alginate) of an acid (alginic acid) that is present in certain seaweeds of the genus *Laminaria* which are abundant on the coasts of Ireland, Scotland, Norway and France. The species giving the most satisfactory results as a source of algin is *Laminaria digitata.*

The seaweed is cut at low tide, allowed to drift ashore, and dried in the sun. The best material for the algin manufacture is that obtained in the autumn.

The seaweed can be used as a source of iodine and other products of value, in which case the first process to which it is subjected is the extraction of the soluble salts, etc., which it contains, by maceration with water, cold water being satisfactorily employed for the purpose. The residue, which has the appearance of the unaltered seaweed, consists of alginic acid together with "algulose" (algic cellulose), the latter making up the cellular fabric of the plant which corresponds to the fibrous cellulose structure of most land plants.

The alginic acid is insoluble in water, but is dissolved out, as sodium alginate, by boiling the material with a solution of sodium carbonate ("soda"). The dissolved sodium alginate is separated from the residue of algulose by filtration. This is a difficult process on account of the extremely viscous nature of the solution, a special type of filter being used for the purpose. In order to obtain the algin in a purer form, hydrochloric acid is added to precipitate the alginic acid. This latter is easily separated by filtration; it is then bleached, and redissolved in sodium carbonate. The solution so obtained is evaporated in a vacuum pan and yields the algin of commerce.

By evaporating it on porcelain or glass slabs it is obtainable in the form of a transparent sheet. This has the appearance of gelatine sheet, from which, however, it is distinguished by the fact that its solution does not gelatinise. Sheet algin, if immersed in very dilute hydrochloric acid, is converted into alginic acid ("insoluble algin") and so rendered insoluble, without affecting its appearance. Sheet alginic acid can be coloured like gelatine and has the advantage of not being soluble in water.

Algin will dissolve completely, though slowly, in cold water. It resembles gum arabic in its general properties, but a 2 per cent. solution is as viscous as a 50 per cent. solution of gum arabic, and a 5 per cent. solution pours with difficulty.

The principal use of algin is as a sizing material in the textile industry. It is also used for the purpose of stabilising emulsions of various kinds, for thickening colours in printing and as a mordant. In the dressing of fabrics it is possible, by passing the fabric through a dilute solution of acid after applying the algin, to convert the latter into insoluble alginic acid, whereby the dressing is made permanent and the fabric waterproof.

Similar results are obtained, for particular purposes, by using, in place of acids, salts of calcium, aluminium, iron, etc., since the alginates of these metals are insoluble.

Algin can also be employed as a defæcating agent for clarifying liquids, e.g. in the manufacture of beet sugar. For this purpose a suitable quantity (depending on the particular case) of algin is thoroughly mixed with the liquid. A solution of an alkaline earth compound (e.g. a lime compound) is added, causing a precipitate of insoluble alginate, which carries down with itself the colloidal impurities present in the solution.

Certain metal alginates have special uses, iron alginate, for example, having applications in medicine.

Though algin is still manufactured in this country, some firms who formerly made it are no longer doing so but are importing their requirements, e.g. from France. Algin is obtainable commercially in a number of different grades to suit different requirements. The demand is small, but is stated to be increasing.

Linaloe Husks from India.—A sample of dried linaloe husks, separated from the fruits of trees grown on a private estate at Bangalore, has been recently received at the Imperial Institute. The trees were grown from seed obtained from Mexico in 1911, probably from the species *Bursera Delpechiana*, and the oil is now being distilled from the fruit husks on a commercial scale. According to the grower the fully ripe fruits, when on the point of bursting, produce one pound of the dried husk from six pounds of fruits.

On distillation at the Imperial Institute, these husks were found to yield 18·1 per cent. of oil.

The oil had the following constants, which are given in comparison with recorded figures for Mexican linaloe oil, which is derived mainly from the wood of species of Bursera.

	Oil from present sample of husks.	Recorded figures for Mexican Linaloe oil.
Specific gravity at 15·5° C.	0·8989	0·875 to 0·891
Optical rotation α_D	− 4·68° at 20·5° C.	− 3° to − 14° (but sometimes dextro-rotatory)
Refractive index n_D 20° C.	1·455	1·460 to 1·465
Acid value	0·7	Up to 3
Ester value	216·7	1 to 42
Solubility in 70 per cent. alcohol at 15° C.	Soluble in 3·3 vols.	Soluble in 1·5 to 2 vols.

The above constants indicate that the present sample of oil distilled from the husks consists largely of linalyl acetate, thus differing from the linaloe oil of commerce, which consists principally of free linalol. The predominance of linalyl acetate in the present oil is indicated also by the specific gravity being higher, and the refractive index lower, than in the case of commercial linaloe oil.

According to some observers the wood oil and fruit oil of the linaloe tree are of similar composition and odour, and differ only in their optical rotation ; the wood oil being generally strongly lævo-rotatory, whereas the oil from the fruits is slightly dextro-rotatory. The present oil from the husks, however, is lævo-rotatory, agreeing in that respect with the wood oil.

A sample of the oil was submitted to essential oil distillers, who considered that under present market conditions it would be saleable in London as a source of linalyl acetate at 3*s.* 3*d.* to 4*s.* per lb. (February, 1931).

The yield of oil from linaloe wood in Mexico is reported to be not more than 2·5 per cent., although the wood is said to yield from 7 to 9 per cent. of oil when distilled in Europe. The yield of oil from the whole fruits is stated to be about 3 per cent. The amount of oil obtained from the husks (18·1 per cent.) is very large and it would be interesting to know what proportion they constitute of the entire fruits.

There have been no regular quotations for linaloe oil in the United Kingdom for the last few years, owing to lack of supplies. The commercial value of the oil is, however, usually about the same as that of the oil of " bois de rose femelle " (or " Cayenne linaloe oil ") from French Guiana. This oil is obtained from the wood of an entirely different tree, the botanical identity of which is not definitely known, but is thought to be *Ocotea caudata* Mez ; it is, however, of very similar composition to linaloe oil and is employed in perfumery for the same purposes. Oil of "bois de rose femelle" was recently quoted in London at 4*s.* per lb. for that produced in Cayenne and 2*s.* 9*d.* to 2*s.* 10½*d.* per lb. for Brazilian oil.

Imperial Bureau of Fruit Production—Horticultural Abstracts.—Under this title the Imperial Bureau of Fruit Production (East Malling, Kent) is now issuing a quarterly periodical, consisting of annotated lists of technical publications and papers relating to fruit growing. The items are classified under the following headings : General Horticulture ; Viticulture, small fruits and nuts ; Tree Fruits (Deciduous) ; Physiology, Chemistry, etc. ; Citrus ; Tropical Crops ; Storage and Transport ; Conferences. An index of the authors of the various articles abstracted is provided. In order to assist readers who may wish to arrange the abstracts in a card index, there is assigned to each its appropriate number in the Brussels International Decimal Classification.

The publication, the first number of which has recently appeared, will be supplied at 1*s.* 6*d.* per number or 5*s.* per annum ; it should be of considerable value to those concerned with fruit cultivation in its scientific aspect in various parts of the Empire.

The Use of Home-grown Larch Poles for Transmission Lines.—In a publication bearing this title, issued by the Department of Scientific and Industrial Research as *Forest Products Research, No.* 8 *Bulletin* (London : H.M. Stationery

Office, 1931, price 2s.), Messrs. Stilwell, Bryan, Chaplin and Latham contribute section reports, giving an account of the methods recommended by the Forest Products Research Laboratory for the treatment of larch poles to render them satisfactory for use in connection with telegraph, telephone and power transmission lines. Hitherto, larch has not been regarded as suitable for this purpose, and larch poles up to the present have not been included by the Electricity Commissioners in their specifications. As a result of a conference between the Forestry Commission and the Electricity Commission, arrangements have been made for the Forest Products Research Laboratory to undertake an investigation to determine whether or not the drawbacks to the use of home-grown larch could be overcome sufficiently to render the timber serviceable for use in transmission lines.

The chief objection to the use of larch is based on the behaviour of creosoted poles used by the Post Office during the War. The creosote did not penetrate the larch to any great depth when the current methods of treatment were employed, and the poles were liable to check and split somewhat severely, thus exposing the unprotected timber to the action of fungi and causing danger to men climbing the poles by means of climbing irons. Experimental work carried out at Princes Risborough has shown that with suitable treatment these difficulties can be overcome. If the larch poles are peeled and incised with a broad knife, satisfactory penetration with the creosote can be obtained. Such incisions have a favourable influence on the cracking which occurs during drying, the cracks being narrower and having less tendency to penetrate to the deeper portions of the wood unprotected by the creosote. The incised poles are somewhat weaker than the untreated larch, but the difference is of no practical moment. The report suggests that the most satisfactory creosote treatment for larch poles is the full cell or Bethell process used when the timber is seasoned to a moisture content of about 25 per cent.

Home-grown Pit-props.—Another Bulletin issued by the Department of Scientific and Industrial Research (*Forest Products Research Bulletin No.* 9; London: H.M. Stationery Office, 1931, price 2s.) records the results of an investigation carried out jointly by the Forestry Commission and the Forest Products Research Laboratory with a view to solving the problem of finding a market for the small size hardwood and softwood material from plantations established by the Commission, with particular reference to the use of the poles for pit-props, large quantities of which are annually imported from the Continent. A prejudice against the use of home-grown pit-props arose during the War on account of the poor quality and condition of the props then available, but additional difficulties are irregularity of supplies, lack of proper selection and preparation of the poles, and their high relative cost. The joint investigation has shown that with satisfactory methods of seasoning and preparation, which are fully discussed, home-grown props can be successfully used in our mines as was shown by actual service tests carried out in collieries in South Wales where many of the props tested lasted equally well and compared favourably with the imported props. The report contains recommendations as to the marketing of home-grown props which compare unfavourably with the foreign product in regard to appearance, occurrence of knots and grading. It is recommended that the props should be carefully graded as to length and diameter, that knots and projections should be carefully trimmed ; the props should also be square cross-cut at the ends, and preferably should be peeled.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

Soils

Ceylon.—According to the Report of the Central Experiment Station, Peradeniya, for 1930, soil-erosion experiments are being conducted on two areas, known respectively as area A and area B. Each area contains six plots of $\frac{1}{16}$ of an acre each, confined by brick walls.

In area A, two plots are under *Indigofera endecaphylla,* two have hedges of *Clitoria cajanifolia,* while the remaining two are controls. All plots are planted with tea, shaded with *Gliricidia.*

During the first year of the experiment, 1926–27, no differential treatments of the plots were employed ; *Indigofera* and *Clitoria* were planted at the beginning of 1927–28. The true effects of the treatments can therefore only be gauged by comparison of the control plots with the treated plots before and after the treatments were applied.

The following have been the actual losses of soil during the four years of the experiment. The figures in brackets represent the percentage of the control plots.

Year.	Control plots. *lb.*	*Indigofera* plots. *lb.*	*Clitoria* plots. *lb.*
1926–27 . .	863·8 (100)	738·1 (85·4)	1055·7 (122)
1927–28 . .	1810·0 (100)	1538·4 (84·9)	2069·0 (114·3)
1928–29 . .	1733·06 (100)	723·25 (41·7)	1416·56 (81·7)
1929–30 . .	1039·7 (100)	321·8 (30·9)	577·94 (55·6)

The cover of *Indigofera* was slow in becoming established and is even now not thick in the lower plot. The effect of both measures, however, has been marked and progressive. Compared with the first year the reduction in erosion effected by the different treatments has been as follows :

Indigofera plots : 85·4–30·9 = 54·5 per cent.
Clitoria plots : 122·0–81·7 = 40·3 per cent.

These are striking figures, but it is to be noted that considerable losses of soil are still taking place from the treated plots.

In area B, two plots are envelope forked twice a year, two plots have silt pits in the drains, while the remaining two plots act as controls. Again no treatments were applied in 1926–27. The following losses of soil have been sustained :

Year.	Control plots. *lb.*	Envelope forked plots. *lb.*	Silt pits in drains. *lb.*
1926–27 . .	1708·3 (100)	1295·4 (75·8)	1241·4 (72·7)
1927–28 . .	3031·0 (100)	3787·5 (125)	[1]
1928–29 . .	1122·8 (100)	1961·9 (174·7)	304·4 (27)
1929–30 . .	739·3 (100)	1280·4 (173·2)	437·7 (55·1)

[1] *Records spoilt.*

The results of this experiment have been criticised because it is frequently held that envelope forking lessens erosion. A good deal undoubtedly depends on the incidence and intensity of rainfall soon after the forking is done, but there is no doubt that in this case envelope forking has increased erosion.

With regard to the silt pit plots it is thought that as there is only room for one silt pit in each drain the test is not a particularly good one, though there appears to be some evidence of benefit from even one pit.

The Report of the Chemical Division of the Department of Agriculture, Ceylon, for 1930, mentions that the soil-erosion investigation work started at the request of the Soil Erosion Committee appointed by Government was continued during the year and the results have been published in the April number of *The Tropical Agriculturist*, 1930. The results of this investigation give an idea of the great damage caused to Ceylon soils by erosion. At this point in the investigation it was found that as much as 15,000 gallons of water flowed per second, carrying silt to amounts varying from 9·4 to 58 lb. per second or from about 130,000 to 820,000 tons per annum.

The Chemical Division also reports that the drainage and leaching trials in 1930 entered their fourth year. A modification in the pots was made by fixing three small outlet pipes on the sides of each pot just above the level of the soil in order to enable surface flow of the excess water. Probably due to the fixing of these pipes, there is a certain amount of reduction in the quantity of drainage waters, and in consequence of this the concentration of the waters seems to be a little greater than that in the previous years; however, the total amount of fertilisers leached out is much less than in previous years. The amount of nitrate leached out from cropped pots is negligible and this would appear to indicate that very little loss of this fertiliser and very much less of others would take place from soil, where perennial crops of root depth varying up to three feet are grown, even under heavy rainfall conditions. A certain amount of lime continues to be leached out from these pots. Although fairly large amounts of nitrates and lime are still lost from the uncropped pots, these are much less than in previous years.

There seems to be a definitive positive correlation between rainfall and drainage from the uncropped pots, but there does not seem to be such a correlation between rainfall and drainage from the cropped pots. Drainage occurs only under heavy rainfall conditions, and if the rain is continuous and heavy the amount of drainage from both the series is about the same.

Malaya.—The Director of Agriculture reports that a considerable amount of time has been devoted to work relating to soil atmosphere. A large number of experimental difficulties had to be overcome before actual work on soils could be carried out. It has been shown that the atmosphere of inland soils consists of the usual 80 per cent. nitrogen, the balance being made up of carbon dioxide (1–6 per cent.) and oxygen (19–14 per cent.).

The soil atmosphere of the coastal soil appears to be considerably more complex, one sample examined from a rice area showing about 27 per cent. marsh gas, 5 per cent. oxygen, 4 per cent. carbon dioxide and 15 per cent. hydrogen. From these figures it seems possible that the presence or absence of this type of atmosphere is of some significance in connection with rice areas.

MANURES

Ceylon.—The Chemical Division of the Department of Agriculture reports that in connection with the investigation into the effect of green manures and manuring on soils, another set of soil samples was taken from the permanent green manure plots at the Experiment Station, Peradeniya, and nitrogen and carbon determinations of these were made. In practically all soils excepting the controls, a slight increase in both carbon and nitrogen contents has been noticed, which goes to show that not only can the carbon and nitrogen contents of the soils be maintained but even slightly increased by careful green manuring. Similarly, the analyses of soil where a crop of *Indigofera endecaphylla* grows under tea has shown that it increases the nitrogen and organic matter contents of the soil and effectively checks the washing away of fine particles of soil by erosion. There has been a steady, though slight, increase in the amount of nitrogen in the soil, since the crop was planted, and the increase in the organic matter of the soils has been very appreciable, being, on an average, as much as 40 per cent. higher than that of the 1925 average.

Further work done on the effect of cover crop on soil moisture confirms the results of previous work that the shade of tree green manure crops exercises a beneficial influence on the soil moisture by reducing evaporation. Greater losses of soil moisture occur from plots where bush green manures are planted if they are allowed to grow during periods of drought. Of all these, cover green manure crops prove best in checking loss of soil moisture during periods of drought.

A laboratory experiment was started to determine the effect of desiccation on nitrification of green manures. *Dadap* leaves and tender stems were used for the purpose. Three sets of pots, one to which green material was added, another one where dried material was used and a third one kept as control, were maintained. The results of this experiment indicated that at all stages of decomposition green material nitrifies more quickly than dried material and at the end of eight weeks the nitrification percentage in the case of the green material was 87·3, whereas in the case of dried material it was only 63·3. Also the nitrogen balance in soils to which the green material was added was higher than that in those where the dried material was used.

The experiment to study the change in composition and decomposability of green manures has been completed. Four types of green manures—viz. *Crotalaria anagyroides*, *Tephrosia candida*, *Dadaps* and *Gliricidia* were used for the purpose. The results of this experiment indicate that the proportion of leaf to stem in the young plants is about 2 : 1 in the case of bush green manure plants and 1 : 1 in the case of branches of tree green manures and these proportions fall down to about 0·4 : 1 and 0·3 : 1 respectively when the plants mature.

They also indicate that the percentages of moisture, nitrogen, ash and pentosans decrease and that of lignin increases in the case of leaf as well as stem as the plant matures, although the total amounts of these continue to increase. The nitrogen content of the leaf is about five times and ash constituents about twice that of the stems. The lignin-pentosan ratio in the case of bush green manures is smaller than that of tree green manures and this ratio was found to increase from 1 to 2 as the plant matured.

Samples of artificial farmyard manure prepared from coconut husk by the Adco process under the direction of the Agricultural Chemist on various estates were submitted for analysis and report. In all, six samples have been analysed, the results of which show that, although the percentage of nitrogen in the decomposed material is nearly double that in the original husk, yet the decomposition was not quite so satisfactory as was expected, probably due to the fact that the husks had not been crushed. On one estate two systems of preparing the manure were tried, one in the pit and the other in the stack. The rate of decomposition was practically the same in both, although the nitrogen percentage in the sample from the pit was lower than the one in the stack as there was an admixture of sand to a great extent in the former sample.

According to the Report of the Mycological Division, diseases of green manure plants and shade trees were of varied and fairly frequent occurrence in Ceylon during 1930. A dieback of branches of *Albizzia moluccana* was attributed to *Irpex subvinosus*; inoculation experiments showed that preliminary wounding was necessary. The same fungus was recorded on the roots of *boga* (*Tephrosia candida*). *Fusarium* dieback of dadap (*Erythrina lithosperma*) occurs fairly commonly; it is usually regarded as a symptom of debility. Numerous instances have occurred of the death of dadaps without apparent cause; *Fusarium* dieback is usually present, but it seems fairly certain that it is a result of previous weakening rather than the cause of disease. Estate practice in Ceylon includes the lopping of dadaps two, three or even four times a year, and after four or five years of such treatment the snags on lopping are so large and numerous that decay sets in from which the tree seems unable to recover. The symptoms vary; there may be a dieback, accompanied by *Fusarium*, or the tree may recover from lopping by putting forth dwarf shoots in place of long ones. These gradually die, and one side of the tree may die back to the main stem. The only remedy would appear to be replacement; it is said that *Gliricidia* is better able to withstand continuous lopping. *Fusarium* wilts of tree lucerne (*Cytisus proliferus*) and *Tephrosia Vogelii* have been recorded for the first time. In both cases only isolated plants were attacked, and it is probable that the plants were weakened by adverse environmental conditions and succumbed to the attacks of a normally saprophytic soil form. *Parodiella grammodes* is common on *Crotalaria anagyroides* and other species, but does little damage. Other records include rust (*Uromyces decoratus*) on sunn hemp (*Crotalaria juncea*), *Rhizoctonia Solani* on vigna and on *Indigofera endecaphylla*, and eelworm (*Tylenchus* sp.) on *Centrosema*. The above records are mostly individual, and it must not be concluded that diseases are widespread among green manures.

INSECT PESTS

Termites

Ceylon.—The Report of the Entomological Division of the Department of Agriculture, Ceylon, for 1930, contains the following information on termites affecting various economic plants and on termites affecting buildings, taken mainly from notes contributed by Mr. Jepson, Assistant Entomologist, who is engaged in the investigation of these pests.

1. *Termites affecting Plants of Economic Importance*

(*a*) *Species concerned.*—The following species of termites which are known to be primary pests of economic plants have been the subject of inquiry during the year: *Calotermes* (*Neotermes*) *militaris*, *C.* (*N.*) *greeni*, *C.* (*Glyptotermes*) *dilatatus*, *C.* (*G.*) *ceylonicus*, *C.* (*Cryptotermes*) sp. and *Coptotermes ceylonicus*.

Of these, *C.* (*N.*) *militaris* was recorded mainly as a pest of tea, and eighteen additional estates have been found to be infested by this species.

C. (*N.*) *greeni* was recorded on four occasions as a pest of *Hevea* and was also found in four new host plants.

Although *C.* (*G.*) *dilatatus* is a serious pest of tea in the low-country districts, few inquiries were received regarding this species, but it was found in one new locality, on two new estates and in two new host plants.

Mention may be made of the finding of the rare species *C.* (*G.*) *ceylonicus* in *Hevea* and *Acacia*, the latter being in a new locality.

An unidentified species of *C.* (*Cryptotermes*) was found infesting *Grevillea robusta* on one occasion, but most of the records in connection with this group of dry-wood-nesting termites are from building woodwork.

The soil-nesting species, *Coptotermes ceylonicus*, has been much in evidence during the year both as a pest of living plants and of building woodwork. This species has proved to be a serious pest of tea and of *Hevea*, and the damage caused to the latter appears to be identical with that of *Coptotermes gestroi*, which is a notorious pest of *Hevea* in Malaya. New host plant records of this species have already been given and new locality records will be mentioned below.

(*b*) *New locality records.*—Localities from which *C.* (*N.*) *militaris* has been recorded for the first time are Hewaheta and Rangalla, but many new estate records have been forthcoming from other districts already known to be infested.

During 1930 the new locality records for *C.* (*N.*) *greeni* are Gampaha, Ingiriya and Weligama and this species was also collected from a new estate in the Ratnapura district. In all these cases the host plant was *Hevea brasiliensis*.

Chilaw is a new locality record for *C.* (*G.*) *dilatatus*, which was also found for the first time on two estates near Pelmadulla and Yatiyantota respectively.

C. (*G.*) *ceylonicus* was collected in the Hewaheta district.

New districts in which species of *Calotermes* (*Cryptotermes*) have been collected are Galaha, Hewaheta and Jaffna. Evidence of the occurrence of the genus has also been obtained from the Badulla and Kadugannawa districts, the characteristic fæcal pellets of these insects being expelled from the woodwork of bungalows in these localities.

Coptotermes ceylonicus was found attacking *Hevea* in the Kurunegalle, Mawanella and Udagama localities for the first time.

(*c*) *New species of Ceylon Termites which attack living plants.*—Mr. Pinto is responsible for the discovery of a new sub-genus of *Calotermes* for Ceylon, namely *Calotermes* S. Str. This typical sub-genus has only twice previously been recorded from the Oriental region. Dr. Kemner of Lund, Sweden, has named this new species *Calotermes* (*Calotermes*) *pintoi* after the collector. Dr. Kemner has also named the following new species during the year: *Calotermes* (*Cryptotermes*) *ceylonicus* collected from *Diospyros insignis* at Chilaw and from *Ficus altissima* at Peradeniya; *C.* (*G.*) *perforans* infesting *Eugenia Jambolana* and *C.* (*G.*) *brachygnathus* in *Mimusops hexandra,* both from Puttalam; and *Leucotermes ceylonicus* sub. sp. *eugeniæ* from decaying portions of *Eugenia Jambolana,* also at Puttalam.

(*d*) *Bionomics.*—Mr. Pinto has continued to be in charge of the living material. There is little to add to the remarks contained in the report for 1929, beyond the fact that the same colonies are still alive and thriving. The most advanced members of the colonies of *C.* (*N.*) *militaris,* obtained from eggs laid in captivity by the winged forms nearly four years ago, still show no indication of developing wing pads, but colonies of *C.* (*Planocryptotermes*) *primus* raised from eggs laid nearly two and a half years ago now have numerous members with well-developed wing pads. A complete knowledge of the bionomics of these insects is necessary for their successful control.

(*e*) *Control.*—The Paris Green treatment of the various species of *Calotermes* has now been adopted on an extensive scale and has met with marked success, particularly in the case of *C.* (*N.*) *militaris* in tea. The method, occasionally adopted, of treating all bushes in an infested area on the assumption that they are attacked is not to be recommended. Paris Green should only be injected into bushes which show definite indications of harbouring living colonies. It is hoped that this method of destroying the colonies in infested plants will be further extended in the near future as, apart from the lives of the attacked plants being prolonged by treatment, the destruction of a very large number of insects, which would otherwise develop to the winged adult state and escape, is thus secured. Unless some organised attempt is made to destroy the large colonies in plants known to be infested a rapid extension of the areas now affected must be expected.

2. *Termites affecting Buildings and Building Materials*

(*a*) *Species concerned.*—A new development of the advisory work of the division has been the marked increase in enquiries relating to the injury caused by termites to buildings and materials employed in their construction. Many of these enquiries related to damage to roof timbers, window and door frames by the dry-wood termites (*Cryptotermes*) and to the serious and extensive injury caused by *Coptotermes ceylonicus*, but the majority of the enquiries dealt with the general question of dealing with the invasion of dwelling houses by other soil-nesting species, of which *Termes horni*, *Cyclotermes redemanni* and *Hypotermes obscuriceps* were the most important. Damage to the extent of many thousands of rupees was caused to the woodwork of two estate factories by *Coptotermes ceylonicus*. In each case the invasion was due to faulty construction and it is to be regretted that so little interest is taken in this important question by architects and builders and also by those for whom the buildings are erected.

(*b*) *New species of Ceylon termites which affect buildings.*—New species of Ceylon termites causing injury to timber and determined by Dr. Kemner during the year are: *Calotermes* (*Cryptotermes*) *ceylonicus* damaging dressed timber at Paiyagalla, near Kalutara; *C.* (*Cry.*) *perforans* infesting building woodwork in Colombo, Kandy and Peradeniya; and *C.* (*Planocryptotermes*) *primus* damaging rafters and ceiling boards of bungalows in Kandy and Peradeniya. The sub-genus *Planocryptotermes* is recorded from Ceylon for the first time. The only other country from which this sub-genus has been recorded is the Philippine Islands.

(*c*) *New locality records.*—Species of *C.* (*Cryptotermes*) have been collected during the year in the Galaha, Hewaheta and Jaffna and Kadugannawa districts for the first time. *Coptotermes ceylonicus* was recorded as causing injury to timber in the Nawalapitiya and Madulsima districts and a species of *Leucotermes* at Paiyagalla near Kalutara, all records being new during the year.

(*d*) *Tests of building materials.*—During the past year ten samples of materials employed in buildings have been received by this division for tests as to their alleged termite-resistant properties. Five of these samples were from commercial firms and the remainder from the Public Works Department. Owing to the use of certain commercial firms of official reports upon their products for purposes of advertisement, tests of this nature have been discontinued. Tests recently conducted and others still in progress, on behalf of the Public Works Department, include the following: Californian Red Wood (*Sequoia sempervirens*); a liquid dressing for rendering timber termite-resistant; a liquid adhesive for attaching linoleum to cement flooring, and two grades of a compressed fibre product employed for ceiling and insulating purposes. Of the latter, one grade has been tested, and the claims of the manufacturers that this material was termite-proof cannot be sustained under Ceylon conditions. An improved grade of the same product is under test at the time of writing. Californian Red Wood, which is said to be termite-proof in America, was readily attacked by the soil-nesting species *Cyclotermes redemanni*. The other preparations are still under test and there are indications at the present time that the linoleum adhesive does not possess the termite-repellent properties which the manufacturers claim for this product. It is the practice in some local buildings to fasten linoleum, and other flooring materials, to cement floors and some of the adhesives used for this purpose are considered to be highly attractive to termites and to invite attack of the floor coverings used. The adhesive now under test is claimed to overcome this objection.

The various products received from commercial firms have been tested and reported upon, confidentially, to the Public Works Department.

(*e*) *Bionomics*.—No advance has been made with the attempts to raise certain soil-nesting species of termites in captivity and to which reference was made in last year's report. All colonies died, due, it is believed, to the difficulty of maintaining a uniform moisture supply.

(*f*) *Control*.—The destruction of subterranean termite nests by the injection of petrol continues to be a very satisfactory method of eradicating newly-formed colonies. Owing to the constant formation of new nests by the winged pairs at swarming time it is necessary that they should be treated as soon as they are discovered in order to prevent the emergence of the winged colonising individuals.

During a part of August and September some trials were carried out on two of the Departmental Experiment Stations to see whether very large termite mounds, mostly constructed by *Cyclotermes redemanni*, could effectively be broken up by explosives, but the method was abandoned as being too costly. All such long-established nests should be demolished by hand labour and in the event of any reconstruction of the nests they can be treated with petrol.

BEVERAGES

Cocoa

Ceylon. The Report of the Central Experiment Station, Peradeniya, for 1930, contains the following account of an attempt to ascertain the cause of sterility in cacao.

At the request of the Director, Royal Botanic Gardens, Kew, a number of trees which appeared to bear very few or no pods were marked during the heavy cropping season in October–December, 1929. Only one tree of normal vigorous growth was found which, as far as could be ascertained, had never borne a crop. The pollen of this tree, together with that of a good bearing tree, was examined by Mr. J. C. Haigh, Assistant Mycologist, whose report is given below:

" Germination tests have been carried out with pollen from a sterile cacao tree at the Experiment Station, Peradeniya. The tree bears abundant flowers, but has never been known to set a pod. Comparative tests were carried out at the same time with pollen from a tree (No. 5 ' B ' cacao) that in the last three series of yearly records has produced respectively 119, 108 and 105 pods.

" The flower of *Theobroma cacao* opens in the early morning; advantage was taken of this fact to ensure that only fresh pollen was used for the tests. In the evening all opened flowers were removed from one branch of each of the trees under examination, thereby ensuring that the flowers picked for experiment next morning were newly opened. The flowers were picked in the early morning and the pollen from them was sown on 1·5 per cent. agar in petri dishes. Five flowers were taken from each tree per day and the pollen from each anther was sown separately; twenty-five pollen masses per tree per day were thus obtained. Normal pollen germinates in a few hours in a moist atmosphere, but for convenience the pollen was examined twenty-four hours after sowing. Germinative power was judged by the percentage of pollen grains that had produced a germ tube. From the good tree 4,664 pollen grains were examined, of which 3,379, or 72·4 per cent., had produced a germ tube in twenty-four hours; from the sterile tree, 4,191 pollen grains were examined, of which only 15, or 0·36 per cent. had germinated in the same length of time. Samples of pollen from the sterile tree were kept for five days, but no increase in germination percentage was observed. Pollen from the good tree was seen to germinate a few hours after sowing. The only observable difference between the pollen from the two trees was that that from the sterile tree contained a small percentage of larger, thin-walled grains. The normal pollen grain examined was about 20μ in diameter and had a thick wall; the larger grains had a thin wall and were about 30μ in diameter."

The above tests show that the failure to germinate of the pollen of the sterile tree is a factor responsible for the sterility of the tree, since self-fertilisation is impossible. It is generally held that the cacao flower is in the main self-fertilised, but Harland has shown that cross-fertilisation occurs in cacao; it is still necessary, therefore, in accounting for the complete sterility of this tree, to explain the failure of cross-pollination. A detailed investigation will probably be necessary before this explanation is found; in the meantime a few simple hand pollinations have been made, using pollen from the good tree of the germination tests. It is perhaps of interest to note that similar tests carried out in the West Indies failed to show a significant difference in germinative power between pollen from good and poor yielders, and that in such trees, which were incidentally the progeny of the same parent, sterility was due to a defect in the female part of the flower."

Nigeria.—Mr. T. Laycock, Senior Mycologist to the Department of Agriculture, in a report for the six months ending December 31, 1930, states that the results of the cocoa fermentation experiments to date lead one to the conclusion that cacao cannot be prepared free from purple beans unless the beans are very mature or unless the fermentation is unduly prolonged. Very mature samples have a high percentage of germinated beans, and over-fermented beans are dark in colour, brittle in texture and tend to be internally moulded. These characteristics are undesirable from the manufacturers' standpoint and therefore it would appear that no method of reasonable fermentation will prevent the occurrence of some purple beans in ordinary cacao. Samples of cacao fermented by changing twice daily, once daily, and only changing at the beginning and towards the end of the fermentation period, have been assessed by brokers at home as having equal value. Cacao from fermentation in large boxes and smaller quantities in small baskets have also realised the same value in the English market. It is evident then that quite unlaborious methods of fermentation, even when applied to small bulks of cacao, will give a cacao of equal monetary value to that obtained when large bulks are treated more laboriously. Also from examination of the dried beans we find that freedom from "insufficiently fermented " beans can be obtained from small quantities of cacao by unlaborious methods of fermentation.

External appearance of beans, whilst in a measure dependent upon condition and degree of fermentation of the bean, is very largely a matter of chance and dependent on the climatic conditions obtaining during curing. By covering halves of beans with a toxic cement and inoculating the exposed half with *Aspergillus* spp., definite evidence was obtained that the fungus gains entrance within the bean at the micropylar end.

In an experiment concerning the moulding of cacao during storage, samples of cacao were stored in the Plantation Store in open boxes and closed bags and were kept under these conditions for over a year. They were then examined and it was found that beans stored in bulk in the open contained more internal moulds than did those stored in closed sacks. On the other hand, the cacao in sacks showed a greater amount of insect-damaged beans than did those in the open boxes. A definite correlation was found to exist between the relative humidity of the store and the moisture content of the beans whether stored in boxes or sacks, although naturally the latter took up less moisture than did the beans exposed to air.

Coffee

Ceylon.—The following summary of the yields of different varieties of coffee grown at the Central Experiment Station, Peradeniya, is contained in the Report of the Station for 1930. As most of the coffee plots are small the yields are stated in pounds of fresh berries per bush. The figures relate to all bushes in full bearing for the last seven coffee years (October 1 to September 30).

ROBUSTA TYPES

Year.	Pounds fresh berries per bush.				
	Robusta.	Uganda.	Quillou.	Canephora.	Hybrid.[1]
1923–24 . .	2·37	3·43	6·91	3·01	8·38
1924–25 . .	4·01	5·29	3·43	3·88	5·62
1925–26 . .	3·23	2·06	3·91	3·09	9·78
1926–27 . .	8·54	8·99	5·01	10·29	7·61
1927–28 . .	5·57	6·86	13·45	7·63	8·26
1928–29 . .	7·44	6·69	6·18	8·55	5·19
1929–30 . .	7·58	7·82	5·94	8·38	7·82
Average . .	5·53	5·88	7·32	6·40	7·66

[1] *The exact nature of this " hybrid " is not known. The bushes are partly of the Robusta type, but the young berries show the bronze colour attributed to Canephora. The seed was obtained from M. Leboeuf, of Paris, in* 1903, *and the coffee is the oldest on the station. Though grown without shade the bushes have consistently borne heavier crops than any others of the Robusta type.*

Liberian Types

Year.	Pounds fresh berries per bush.				
	Excelsa.	Abeokuta.	Liberia Pasir Pogor.	Klainii.	Arnoldiana.
1923–24 . .	5·56	9·16	6·68	—	—
1924–25 . .	19·82	12·84	13·34	—	—
1925–26 . .	14·00	15·26	11·71	—	—
1926–27 . .	25·80	18·94	21·21	—	—
1927–28 . .	19·75	17·77	12·76	6·54	2·00
1928–29 . .	22·00	31·20	27·16	2·54	2·50
1929–30 . .	26·16	32·28	29·69	10·14	3·50
Average . .	19·01	19·92	17·51	6·41	2·66

Arabian Types

Year.	Pounds fresh berries per bush.		
	Arabica (Plot 140 I.)	Kents.	Jackson's Hybrid.
1923–24	2·39	—	—
1924–25	2·39	·64	·18
1925–26	2·00	1·34	1·39
1926–27	3·26	·21	·58
1927–28	1·27	·69	·15
1928–29	1·93	1·84	·76
1929–30	1·20	·67	·53
Average	2·06	·89	·51

For further information on Robusta coffees *Bulletin No.* 87, "The Cultivation and Commercial Possibilities of the Robusta Types of Coffee," published in June 1930, should be consulted.

The large yields of the Liberian types are noteworthy, but the proportion of pulp to seed is about double that of the Robusta kinds. Sun-dried coffee of the Liberian types always fetches about half the price of that of the Robusta types. The average prices realised during 1930 have been as follows :

Robusta types, sun-dried coffee, 11½ cts. per lb.
Liberian ,, ,, ,, 7 ,, ,,
Robusta ,, parchment ,, 18 ,, ,,

These prices are approximately half the normal prices quoted in *Bulletin No.* 87. It is not thought, however, that this fall in local price is due to over-production but rather to a fall in purchasing power of buyers, following the general depression.

Tea

Malaya.—In a report for the half-year ending December 31, 1930, the Director of Agriculture states that considerable attention has been given to the experimental cultivation of tea at Serdang and the total area under this crop is now approximately 30 acres. The whole area was carefully pruned during September–October and systematically manured. Immediately after pruning was completed, the mature area was manured with a " pruning mixture " and the immature areas with a " new clearing mixture."

A further supply of tea seed was received from Assam at the close of the year and this will be utilised for increasing the area under tea experiments.

An experimental tea factory is now being erected on the plantation and will be completed early next year. This factory, which is designed on the Ceylon type of building, is to be equipped with modern tea machinery, capable of dealing with an output of approximately 75,000 lb. of made tea per annum. In addition to carrying out experiments in the manufacture of tea on the plains in this country, it is considered that this experimental factory will prove of great value in demonstrating the method of manufacturing tea as commonly practised in Ceylon and Southern India.

At the present time there are thirty one-acre plots, comprising ten different jats of tea established on the plantation. The majority of these plots were planted during 1928 so that they will come into bearing during 1931, when it should be possible to ascertain the most suitable jats for cultivation on the Highlands.

Extensive preparations are being made for extending the area under tea and further jungle is being cleared with this object in view. Arrangements are also being made for the erection of a small tea factory at Tanah Rata and a certain amount of tea machinery has been ordered from Ceylon for this purpose.

CEREALS

Rice

Ceylon.—The following summary of manurial experiments with rice conducted by the Division of Economic Botany, Department of Agriculture, Ceylon, is contained in the Report of the Division for 1930.

The experiments have not yet been carried out for a sufficiently large number of years to allow more than general conclusions being drawn as to the results of most of the treatments tried. There is, however, very definite evidence of the value of green manure at all stations except Labuduwa, where the soil is naturally richer in organic material, but even at Labuduwa, when the limiting factor of phosphoric acid is added, the application of green manure has been beneficial. The decomposition of the organic matter furnished by green materials, weeds and crop residues, not only supplies plant food for the rice plant, but also supplies carbon dioxide for the algæ which are supposed to be so important in the supply of oxygen to swamp rice. Where crops occupy the land for the majority of the year (as in parts of the Central Province), or where natural weed growth is poor in quantity (as in dry districts and where fields are grazed bare by cattle) the application of at least some additional green material is important, and in some places may be essential if the full benefit of applying artificial fertilisers is to be obtained.

The application of superphosphate and steamed bone meal alone has given economical results at all stations, and it must be concluded that phosphoric acid is perhaps the most important plant food to be added to Ceylon paddy soils. It is estimated that the application of 1 cwt. of ordinary superphosphate or of 100 lb. of steamed bone meal will give on average soils an increase of about 25 per cent. with a residual effect on the succeeding crop of about 12 per cent. The addition of small dressings of sulphate of ammonia to these manures has had no effect. There is evidence, however, that with larger dressings of superphosphate additional nitrogen will be effective, and it is thought that if superphosphate is applied alone for a number of years yields will fall off unless nitrogen is also given.

The addition of potash to nitrogen and phosphoric acid has had no effect and it may be concluded that applications of potash are not necessary on Ceylon paddy soils.

Apart from the effect of phosphoric acid alone, and of green manuring, the chief interest in these trials is the effect of the different ammonium phosphates. The value of this compound fertiliser has been masked at Anuradhapura owing to the high fertility of the fields. The control plots yielded at the rate of 2,568 lb. per acre, which for unmanured land is a yield which compares favourably with yields in any part of the world. Some explanation of the quantities per acre of the fertilisers used in this series is necessary. Treatments 1, 2 and 4 at the time the experiment was started were based on equal costs. Prices have varied since then. Treatments 3 and 5 contained similar amounts of nitrogen as treatment 1 on the analyses then available. The data which are available here are not exhaustive, but they indicate that moderate dressings of the ammonium phosphates with the wider ratio of nitrogen to phosphoric acid are generally more effective. On less fertile soil it is probable that the use of a narrow ratio ammonium phosphate is advisable.

The following general recommendations for manuring paddy fields are given :

1. For fields which carry between crops a luxuriant weed growth and where nitrogen can be assumed to be present in sufficient amount, ¾ to 1 cwt. of concentrated superphosphate followed when yields go off by ¾ to 1 cwt. of a wide ratio ammonium phosphate.

2. For fields of average fertility, ¾ to 1 cwt. of a wide ratio ammonium phosphate followed in later years by 1 cwt. of a narrow ratio ammonium phosphate.

3. For poor soils and where the above fertilisers do not succeed in maintaining yields, 1 cwt. of a narrow ratio ammonium phosphate.

Superphosphate is best applied at the final ploughing and ammonium phosphate about a day before sowing or transplanting. The addition of green manure to the above dressings is recommended unless weed growth is very large. A suitable average amount to apply is one ton per acre, but even smaller amounts will be beneficial.

Diammonphos and Leunaphos tried in the new series C are not now on the market. The ammonium phosphates available are as follows :

Wide ratio	ammophos . .	13/46
	nicifos . .	17/45
Narrow ratio	ammophos . .	20/20
	nicifos . .	22/18

The first figures show the percentage of ammonia and the second the percentage of phosphoric acid.

Information as to the optimum dressings per acre on different soils is not yet available, but it must not be assumed that the amounts mentioned above are maximum dressings. It would, however, be unwise to exceed them unless the water supply is ample.

The Report of the Chemical Division for 1930 contains the following statement relating to an experiment which is being carried out to test the keeping quality of rices.

The experiment was started to determine to what extent each of the factors, viz. the presence of testa and the moisture content of the rice, that affect the keeping quality of rices, is responsible for their growing black or mouldy.

Unpolished, ordinarily polished and thoroughly polished samples of both raw and parboiled rices were used for the experiment. It was also thought desirable to study the correlation between humidity and moisture contents of these rices. All the samples were kept out in bags.

The experiment is in progress and the results so far obtained indicate that raw rices keep better than parboiled and that the more polished the rice is, the better is its keeping quality. At the end of a period of two months all the samples of parboiled rice were affected, the sample of unpolished rice growing very mouldy and turning black. It was further observed that with an increase in the humidity of the atmosphere the parboiled rices absorb more moisture than the raw ones.

According to the Report of the Mycological Division for 1930, Mr. Bertus' work on the sclerotial diseases of paddy is being concluded. Further investigations into the viability of the sclerotial fungi associated with diseases of rice have shown:—

(*a*) That *Rhizoctonia Solani* retains its viability in air-dried paddy soil for more than 130 days; that sclerotia buried to a depth of 1½ in. in moist paddy soil are viable after 133 days and that sclerotia submerged in 3 in. of tap-water are viable after 224 days. In the latter case the water developed a rich growth of an alga of the *Chlorella* type, such as occurs in paddy fields. Sclerotia on air-dried soil were exposed to the sun for a limited number of hours during successive days and lost viability after exposure for 204 hours during a period of 38 days. The mean solar temperature during the period was 56·6° C.

(*b*) That sclerotia of *Sclerotium oryzæ* remain viable for 133 days when buried 1 in. deep in moist paddy soil, for 525 days when kept in a corked tube under dry conditions, and for 319 days when submerged in tap-water. They were killed by immersion in water for 385 days and by exposure to sunlight for 145 hours during 28 days. The mean solar temperature was 59·2° C.

FRUITS

Citrus

Leeward Islands.—*Dominica.*—Mr. F. G. Harcourt, Agricultural Superintendent, Dominica, reports that the investigational work of his Department is principally concerned with the causes relative to the decline, or almost destruction, of Dominica's staple industry, namely the seedling lime industry. These may be briefly outlined as follows:

1. The advent of withertip disease, 1922.
2. The epidemic of root disease, commencing in 1926.
3. The severe storms or hurricanes of 1926, 1928 and 1930.

The following table giving the crop shipped since 1921 (calculated in barrels of fruit and expressed in round numbers) will illustrate the rapid decline of the seedling lime industry through the above-mentioned causes.

1921	516,000			
1922	400,000	Withertip.		
1923	228,000	,,		
1924	424,000	,,		
1925	230,000	,,		
1926	214,000	,,	Root disease,	hurricane.
1927	210,000	,,	,,	
1928	205,000	,,	,,	,,
1929	133,000	,,	,,	
1930	114,000	,,	,,	,,

Withertip Disease of Limes (*Gloesporium limetticolum*).—This disease was first observed in Dominica early in 1922, and it spread with such alarming rapidity that by the end of that year very few, if any, lime cultivations were unaffected. Although the crop exported in 1924 was inflated by a large carry-over of products from 1923, the reduction in the years following attributable to this disease was in the neighbourhood of 40–50 per cent. of normal crop.

Efforts to control the disease proved of no avail, spraying with fungicides being useless owing to the frequency of heavy showers of rain for which Dominica is noted. Consequently lime cultivations in the interior where the rainfall is always high were soon rendered un-economic and had to be abandoned. Cultivations on the drier coast lands, however, proved less liable to attack and continued to make good yields, especially when dry weather was experienced at the time the trees were in flower. Efforts were made by the Agricultural Department to discover a lime with the properties of the fruit in every way similar to the West Indian lime, yet immune to withertip disease. Many introductions of sour citrus were made, of which Woglum's lime, Bears Seedless lime and Tahiti came nearest to the filling of these requirements, and are being given a field trial on an estate situated in a withertip area. The Bears Seedless and Tahiti varieties are not proving very heavy bearers and may have to be rejected on this account, unless growing on a stock other than Sour Orange should remedy this fault. The Woglum lime is proving itself a heavy bearer, but its drawback is the fact that the fruits are rather large for the green lime trade. All these varieties have been proved to be highly resistant if not immune to withertip disease.

The Department has, however, raised a considerable number of crosses between the West Indian lime and the Woglum and it is amongst these that it is hoped to find a lime for the wetter districts of this island. These young trees are healthy and making good growth, and should bear fruit during the coming year. All are grown on an estate acquired by the Government which had become derelict owing to withertip disease. Considerable variation in foliar characteristics are to be observed in the plants, and a few absolutely resemble the West Indian lime which was used as the male parent. The foliage of the Woglum lime which was used as the female parent is quite distinct from the lime and resembles very much the lemon. The resistance to withertip disease is very marked, and most of the crosses would appear to be immune, for they have escaped attack during the last three years they have been under observation. The prospects for the success of this work are most encouraging.

Red Root Disease (*Sphaerostible repens*) *and Hurricanes.*—In July, 1926, Dominica experienced a hurricane of severe intensity and seedling lime cultivations were badly damaged. This storm and the protracted wet weather which followed were to a large measure responsible for the incidence of root disease appearing at the end of that year, and which within three months had spread to an alarming extent, even the best cultivated estates being affected. Undoubtedly the loosening and twisting of the roots of the trees set up conditions peculiarly favourable to the spread of the disease. All efforts to control the disease proved useless. A further hurricane was experienced in 1928, which was of greater intensity than the one of 1926. Lime cultivations weakened by disease showed but little resistance to the strong winds and thousands of trees were destroyed. Root disease became more active after this storm and in 1929 there was scarcely an estate in the island unaffected. So rapidly did the disease spread that it soon became evident that the seedling lime tree was doomed in Dominica. A further hurricane experienced on September 1 last year made a total of three in four years, and was of far greater intensity than any of the others mentioned, resulting in almost complete destruction of such seedling lime cultivations as remained.

It had been observed by the Department that the sour orange tree was apparently immune to this disease, and further that its deep root system enabled it to stand up successfully against winds of hurricane force. In the Department's trial grounds there is a plot of limes budded on the sour orange as a stock. These were planted in 1913, and although disease and wind have been responsible for the death of the seedling limes grown in the same vicinity, not one of the budded trees has been uprooted or attacked by root disease. Furthermore, it has been definitely proved that the yield of fruit from budded trees is far greater than from seedlings, and in 1923 the calculated yield per acre was as high as 528 barrels. The superiority of the budded tree has now been so pointedly demonstrated in the face of calamities experienced, that the planters have no further thought of growing seedlings.

Budding the lime on the sour orange stock is therefore the solution to the problems created by hurricane and root disease. In Dominica planters practically rely upon the Agricultural Department for their planting material and the magnitude of the task confronting this Department in raising a sufficient number of budded plants to replant the area under Dominica's staple industry can well be imagined. Good progress has, however, been made, and 31,794 of these plants have so far been propagated and distributed. The nurseries of the Department have been considerably extended and work so organised that every demand for this class of plant will be met during the coming year.

Experiments are to be conducted with various forms of citrus stocks in order to determine their adaptability to soil and scion, resistance to disease and influence on crop production.

Jak Fruit (*Artocarpus integrifolia*)

Ceylon.—According to the report of the Entomological Division of the Department of Agriculture, Ceylon, for 1930, a serious outbreak of the caterpillars of a Bombycid moth (*Ocinara varians*) occurred on at least two young jak plantations during the year. This insect was previously recorded from various species of *Ficus*, but this seems to have been its first appearance as a pest of jak. The outbreaks were eventually controlled naturally by birds, principally mynahs, by a predaceous bug (*Canthecona robusta*) and by at least two species of small hymenopterous parasites. Insecticidal tests on a small scale have indicated that a soap solution at the rate of 1 lb. of hard or of soft soap to 8 gallons of water will kill the young larvæ, while the older larvæ require 1 lb. to 6 gallons. This treatment would only be practicable under field conditions where knapsack sprayers could be used on fairly small trees.

The life-history of this pest has been worked out by Mr. de Alwis.

Pineapples

Ceylon.—The following statement regarding a trial with pineapples at the Central Experiment Station, Peradeniya, is contained in the Report of the Station for 1930.

A plot of ¼ acre has been under Kew pineapples for 5 years. The table given below shows the returns and expenses of this plot from the start of the trial:

—	Number of fruits per acre.	Weight of fruits per acre.	Average weight of fruits.	Expenditure per acre.	Revenue per acre.	Profit per acre.
			lb. oz.	*Rs. cts.*	*Rs. cts.*	*Rs. cts.*
April, 1924, to June 30, 1926 .	3,443	20,840	6 3	702.34	1415·88	713.54
July 1, 1926, to June 30, 1927 .	2,052	8,532	4 2	162.40	813.52	651.12
July 1, 1927, to June 30, 1928 .	1,820	8,752	4 12	103.48	765.20	661.72
July 1, 1928, to June 30, 1929 .	3,528	17,240	5 0	84.82	1079.48	994.96
July 1, 1929, to June 30, 1930 .	380	312	3 1	135.20	662.60	527.40

Annual interim reports have been submitted and the very high profits obtained have been commented on. Attention, however, must be drawn again to two factors which are largely responsible for these profits:

1. The entire crop has been sold without difficulty to the labour force of the station and to officers of the Department at prices fixed by the Manager according to the size of the fruit. There have been, therefore, no packing, transport, or marketing expenses.
2. A substantial revenue has been derived from sale of suckers at 10 cents each. Although this is a legitimate source of revenue from pineapple cultivation, a small-holder would not normally have the facilities for such sale which are afforded to the Station. The demand for Kew pine suckers is usually in excess of the supply. The revenue actually obtained from fruit and suckers respectively has been as follows:

Year.	Sale of fruit.	Sale of suckers.
	Rs. cts.	*Rs. cts.*
1925–26 . . .	321.47	32.50
1926–27 . . .	114.18	89.20
1927–28 . . .	153.80	37.50
1928–29 . . .	269.87	—
1929–30 . . .	21.85	143.80

The figure 143·80 shown as sale of suckers in 1929–30 includes the value of 1,176 suckers used for planting another area on the station. This sum is included, since these suckers could otherwise have been sold to the public.

The plot has received the following manuring. Previous to the original planting 10 cartloads of incinerator ash and refuse was ploughed in. A similar application of the same material was forked in in December, 1926. Analysis has since shown this material to be of insignificant manurial value. In November, 1929, 10 cartloads of cattle manure were forked in. No artificials were applied. After the first year a sharp decline in yield and average weight of fruit is noted. In the next year the figures are approximately the same, while in the fourth year a somewhat startling rise in crop appears. This is explained by a record in November, 1926, that where one sucker only was left on the old stalk the plant was dug up and a new sucker planted. Pineapples at Peradeniya take about 18 months or more from planting to the ripening of the first fruits and these newly-planted suckers therefore mostly matured their fruits in 1928–29. This improvement, however, was not maintained and the decline in 1929–30 must be attributed to soil exhaustion. Apart from the revenue from sale of suckers a loss of Rs. 12.95 was incurred in the last year.

The average weights of fruit and sale prices have been as follows :

	Average weight of fruits.		Average sale price.
	lb.	*oz.*	*Cents.*
1925–26	6	3	38.2
1926–27	4	2	29.4
1927–28	4	12	33.5
1928–29	5	0	36.2
1929–30	3	5	23.0

The conclusion to be drawn is that given favourable marketing facilities the cultivation of Kew pines for sale as fresh fruit on a small scale can be extremely profitable, but that the cultivation should not be continued on the same land for more than 3 or 4 years.

SUGAR

Cane

Leeward Islands.—*Antigua.*—The chief work carried out by the Agricultural Department, Antigua, during 1930, was a continuation of the investigation of gumming disease, by Mr. J. L. Illingworth, Special Assistant for sugar-cane diseases. This officer has prepared a résumé of the past work and a report covering the period ending March 31, 1930, which will be printed in due course. The following summary of the report is taken from the Annual Report of the Agricultural Department for the Leeward Islands, 1929-30.

Ba.11569 being the only cane in commercial cultivation in Antigua at all susceptible to the disease the investigations have continued in the form of an intensive study of its incidence on this variety.

The incidence of leaf lesions in canes grown for the 1930 crop clearly showed that in Antigua transmission is chiefly dependent on the mutual bruising of leaves chafing against each other. Without exception fields continued to show only the occasional lesions attributed to insect transmission until such a stage of growth was reached as to bring about general contact. Once leaf contact became general leaf infection spread very rapidly. It is suggested that the carry-over of the disease from crop year to crop year may be due to occasional stand-over fields acting as reservoirs for insect transmission.

As regards stem infection it has been found that both in plant canes and in ratoons this has been considerably less in 1930 than in 1929, and it is suggested that the relatively high percentage infection of canes in 1929 may be correlated with the passage of the hurricane of September 12, 1928.

The general course of the incidence of stem infection in Ba.11569 would appear to be as follows :

(*a*) Prior to the development of general leaf infection practically no stem symptoms are to be found. Systemic infection due to the passage of the pathogen from previously infected root stocks or cuttings into the young ratoon or plant cane shoots does not appear to occur.

(*b*) Stem infection follows general leaf infection within a comparatively few weeks.

(*c*) For a few weeks after the inception of stem infection the young canes are highly susceptible and infection proceeds rapidly.

(*d*) This susceptible phase continues, on the average, for from six to ten weeks after first infection and is succeeded by a phase of high resistance which lasts for the remainder of the life of the cane. Thus the percentage infection six to ten weeks after first infection, that is at the end of the susceptible phase, differs but slightly from that obtaining in the mature cane months later.

(*e*) There is only a slight increase in intensity of infection during the resistant phase.

(*f*) Percentage infection of different portions of the cane showed the same distribution, with a maximum three-quarters of the way down the cane, in the young canes when infection was first observed as in the mature canes immediately before reaping. This, together with the above observations on intensity, seems to indicate that during the resistant phase the pathogen is enabled to travel up and down the vessels of the vascular bundles at a rate approximately equal to the rate of elongation of the cane and that passage from bundle to bundle, which would give rise to increased intensity, is rare. This is surprising in view of the anastomosing of the bundles at the nodes.

(*g*) The longer general leaf contact and hence the incidence of stem infection is delayed, the lower the final percentage infection. It has been found impossible to correlate this with any meteorological or other conditions.

As regards the question of systemic infection already referred to under (*a*), experiments were conducted to determine the effect of infection on the germination and growth of cuttings. Infection has no unfavourable effect on germination, and although the growth rate appears to have been lower in plants from infected cutting examination of shoots from these cuttings after 50 days' growth failed to give any evidence of the presence of the causative organism.

As was the case in 1929, a marked diminution in the stem symptoms in first and more particularly second ratoons was again observed in 1930. So far no adequate explanation has been found for this phenomenon.

Up to date there is no evidence that the general infection of the variety Ba.11569 has reduced its economic value to any extent. Should it, however, be decided to continue its cultivation it will be necessary to keep it under careful supervision for any signs of breaking down.

OIL SEEDS

Coconuts

Ceylon.—According to the Report of the Plant Pest Inspectorate for the Southern Division, for 1930, on an estate which was using kitul trunks as traps for the red weevil of coconuts, it was discovered that the insect completed its life-cycle in a much shorter period than was hitherto supposed. An investigation of the matter was accordingly undertaken by Mr. C. N. E. J. de Mel during the early part of the year. An experiment was made by introducing two pairs of red weevils into a kitul trunk five feet long, split in two, the two halves being replaced together. Larvæ from the eggs laid by the weevils are found in the full adult stage within four or five weeks. The larvæ had reduced the kitul trunk to such a state of decay in this time that the adverse conditions of the decayed trunk may have shortened the larval period. It is pointed out that further experiments are necessary to decide the exact lengths of the various stages of the life-history. It is to be noted, however, that the insect can reach the adult stage within a damaged tree in about five weeks.

Reference to this question is also made in the Report of the Entomological Division for 1930, where it is mentioned that the life-cycle of the red weevil (*Rhynchophorus ferrugineus*) is given in Departmental publications as ranging from 11½ to 15½ weeks. In view of the experience in the Southern Province it was decided to repeat the life-history experiments carried out some years ago at Peradeniya, since it seemed probable that the earlier experiments were not made under normal conditions. In these new experiments, carried out by Mr. Bonney, the female beetles were allowed to lay eggs in the crown of freshly cut coconut palms and the following results were obtained : Egg stage from 2½ to 5 days ; larval stage from 28 to 33 days ; pupal period from 17 to 25 days. The weevils, after emerging from the pupal skin, may remain inside the cocoon for about 7 to 10 days before coming out ; egg-laying usually begins within about 3 to 5 days after the weevils emerge from the cocoons or within about 10 to 15 days after they attain the adult stage. The complete life cycle from egg to weevil is therefore from about 8 to 10½ weeks under insectary conditions at Peradeniya ; it may possibly be even shorter under favourable conditions in coastal areas or at low elevations. Therefore to be on the safe side it is essential that trap pits should be examined and cleared out once a month.

Malaya.—Mr. F. C. Cooke, Assistant Chemist for Copra Research, has furnished the following Report on Copra Research Work for the half-year ending December 31, 1930.

Nut Harvesting and Fruit Storage.—Large-scale experiments have been conducted on six estates to determine the correct time to harvest nuts so as to obtain the highest oil and copra yield per nut. It has been found that when they are ripe and brown, are commencing to fall naturally, and contain an " apple " of about 1 in. diameter, the highest yield is obtained.

There does not appear to be any advantage in storing nuts prior to drying.

Copra Drying.—Small-scale experiments to date have shown that the percentage oil content as determined by ether extraction can decline when coconut meat is dried under a variety of conditions, although no volatile matters appear to be evolved. Grated copra in particular very readily turns yellow and shows a markedly decreased oil content. This was demonstrated both on the industrial scale and also in the laboratory. Further work is in progress.

A design has been prepared for an experimental kiln of the Ceylon type to be installed at the Klang Experimental Station.

Coconut Charcoal.—Renewed enquiries from England and the improved price now offered for this by-product have resulted in a further review of the situation with a view to its export.

Insects and Moulds.—Heavily insect-ridden copras from eleven world sources have been examined. After the copra was brushed clean of all its adherent fibrous dust, the residual copra in most cases showed a normal oil content. The loss of dry copra was estimated to amount to half the original weight.

Work on the study of copra moulds in conjunction with the Mycological Division is proceeding and several pure mould cultures have been prepared.

Copra Baling.—Further consignments of baled copra have been examined and the results have again shown that this method of packing neither causes oil loss nor exceptional free acid formation.

Copra of the lowest grade was also baled and after storage for 14 days in Malaya in open formation in a stack was ready for shipment to Europe, the moisture content having become reduced to the normal for Malayan copra.

Ceylon Copra.—A large number of Ceylon seed nuts have been examined and the results have shown that the Ceylon nuts as received here contain less meat, but more oily meat than typical Malayan coconuts. From information received, however, the Ceylon trees yield more of these small nuts per tree.

Ground-nuts

Nigeria.—According to a report furnished by Mr. E. H. G. Smith, Agricultural Botanist, Southern Provinces, a yield trial of four ground-nut selections, previously made at Ilorin, was conducted at Ibadan during 1930. Three of these selections were of the small (or Ilorin) type of ground-nut and the fourth of the large (or Chinese) type. The present Moor Plantation ground-nut, which was used as standard, was obtained from Zaria and is termed "imported Zaria." Fisher's method of randomised blocks was adopted for the trial. The yields of the standard P and the four selections 14, 21 and 22, Ilorin type, and 29, Chinese type, were as follows :

—	Strains. Yields per acre in lb.				
	P.	14	21	22	29
Dry undecorticated nuts	1,650	1,640	1,740	1,300	1,430
Dry kernels	1,250	1,215	1,275	975	1,070

As the differences between the varietal means exceed those for a 100 to 1 chance, it may be concluded that strains 21, P and 14 are definitely superior in yield to strains 29 and 22 and that 29 is also superior to 22. The difference between strains 21 and 14 just exceeds that for a 20 to 1 chance and between 21 and P for a 10 to 1 chance, while the difference between strains P and 14 is quite insignificant. Therefore it can only be concluded that there is an indication that strain 21 is superior in yield to strain 14 and, less probably, superior to the plantation standard P.

Mr. J. K. Mayo, Agricultural Botanist, Northern Provinces, reports that selection in the local types (both spreading and erect) has produced several high-yielding strains.

In the 1930 yield trials at Samaru, using randomised layout, the best spreading strain was 22 per cent. better than the local spreading variety and the best erect strain was 19 per cent. better than the local erect variety. The yields were calculated as kernels, thus taking account of the different hulling percentages.

In the yield trials at Kano, again using randomised layout, where the spreading type only is grown, the strain which yielded best at Samaru was 19 per cent. better than the local Kano variety, but two of the locally selected strains were 24 per cent. and 21 per cent. better than this variety.

All these trials were carried out on a small scale owing to the small quantities of seed available from the breeding plot. The unit plot in these trials was $\frac{1}{180}$ acre with 48 plants arranged in three rows of 16 at Kano. At Samaru there were three rows of 25 giving 75 plants per plot. The spacing was 2 ft. at Kano and 1 ft. 3 in. at Samaru. The rows were 2 ft. 6 in. apart at both stations.

The seed of the best strains in these yield trials will be used for yield trials on a larger scale in 1931.

Oil Palm

Malaya.—The Director of Agriculture has furnished the following report on work carried out during the half-year ending December 31, 1930.

With a view to investigating the manurial requirements of oil palms, a scheme of manurial experiments is being carried out at Serdang on an area of two acres of oil palms in Block 21. As a result of preliminary observations of yield taken over a period of 1½ years it was decided to divide the area under experiment into 12 plots of 10 palms each. The scheme provides for three different forms of manurial treatment and an unmanured control, which allows of three replications of the experiment. It was decided in the first instance to apply quick-acting manures divided into two applications at intervals of six months, namely in July–August and January–February. The first application of manures was made early in August, and weekly records of the individual yield of the palms in each plot are now being taken in order to test the effect of the various manures on the yield of the palms under experiment compared with the untreated controls.

The results of an experiment in the artificial pollination of oil palms growing under field conditions on an area of approximately 20 acres in Block 5D, which has been in progress since January, 1926, have been summarised for publication in the *Malayan Agricultural Journal*. The results of this experiment show that the palms pollinated artificially gave an average increase of 107·8 per cent. over the unpollinated controls taken over a period of approximately four years, which clearly indicates the necessity for artificial pollination in the case of young palms. It is intended to continue the experiment in order to ascertain whether this large increase in yield, due to artificial pollination, is maintained as the palms increase in age.

Experiments have been carried out at Serdang in the crossing and "selfing" of 10 of the highest-yielding palms growing under avenue conditions, with the result that to date 69 distinct crosses and 4 "selfs" have been successfully established from known parentage. Half-acre plots of 28 crosses were planted up in Blocks 10A, 17 and 18 during October–November, 1930, in order to ascertain whether the high-yielding characters of the parents, grown under avenue conditions, are maintained in the progeny when grown under normal plantation conditions. Control palms, produced under ordinary estate conditions, have been planted between every four rows of the selected palms for purposes of comparison when the palms come into bearing. Further, individual records of yield have been made of the palms from which the various crosses have been produced since they commenced to fruit in August, 1924, and these records are being continued.

The equipment of the experimental oil palm factory at Serdang was augmented during the period under review by the installation of a Stork Single Press, complete with stirring kettle and hydraulic pump, for the extraction of palm oil. This press has a capacity of 500 kilogrammes of cleaned fruit per hour, which is approximately the same capacity as the centrifugal extractor installed during 1929. It will now be possible to test the comparative efficiency of the press and centrifugal systems of extracting palm oil from fruit produced under exactly the same conditions. At the same time it will prove of considerable value in demonstrating to visitors an alternative system of extracting palm oil which is universally adopted in the Dutch East Indies.

A further valuable addition to this plant is the installation of de Laval Separator for the purification of palm oil, the erection of which is now nearing completion. By the utilisation of this purifier it will be possible in future to produce palm oil practically free from dirt and moisture.

An attack has been made during this half year on the problem of determining the total amount of oil which enters an oil-palm factory; experiments have been conducted which have had as their object a positive determination of this quantity, by direct methods, and not by the method of adding together the known quantity of oil produced, plus the known quantities wasted.

The result of experiments shows that owing to the large range of variation in oil content of a fresh oil-palm fruit to its weight, a considerable number of fruits are required to give a representative fraction. This has meant that any of the usual laboratory methods breaks down at this point, owing to the limited size of apparatus and the expense of chemicals. A small-scale factory method to meet these difficulties is at present under investigation.

A considerably quicker method than that of Soxhlet for determining the oil and moisture content of fibrous residues has been devised and found satisfactory.

This half year has seen considerable changes in the procedure at Serdang, especially as regards the methods of harvesting and stripping the fruit. New machinery has been installed and other is in the process of being installed. This has interrupted systematic research work.

The analysis of oil palm bunches from various estates to determine the removal of nutrients from the soil has been continued.

Nigeria.—Mr. E. H. G. Smith, Agricultural Botanist, Southern Provinces, has supplied the following statement regarding the yields of the Calabar Plantation oil palms. The table below shows the yields for 1929, together with the average yield for six previous years, expressed as lb. of fruit per acre :

Type of palms.	Plot No.	No. of years since plot planted out.	Spacing.	Yield (lb. of fruit per acre).	Average six previous years.
Ordinary thick-shell palms	4	17	20 ft. triangular	3,900	—
	6	17	30 ft. square	4,480	3,540
	10	16	25 ft. square	4,520	4,110
	11	14	25 ft. square	5,140	3,860
	12	14	25 ft. square	11,480	6,610
Ordinary thin-shell palms	4	17	20 ft. triangular	3,510	—
	10	16	25 ft. square	4,410	3,260
Mantled thick-shell palms	11	14	25 ft. square	4,890	4,520

The highest oil-palm yields at Calabar are obtained from the few mature trees of the four types, ordinary thick-shell and thin-shell, and green-fruited thick-shell and thin-shell, growing in plot 12. The average yield per mature tree for 1929 of all types in this plot exceeded 200 lb. of bunches per tree with an average yield for the green-fruited thick-shell palms of 290 lb. of bunches per tree.

FIBRES

Cotton

Nigeria.—Mr. E. H. G. Smith, Botanist, Southern Nigeria, in a report covering the half year ending December 31, 1930, gives the following summary of the results of an investigation, extending over two seasons, showing some of the effects of inter-cropping with yams upon the Ishan cotton plant.

Due to inter-cropping, there is a basic or primary depression in growth of some ten per cent. from which no recovery takes place. A retardation of growth occurs due to competition with the yams for the available soil moisture during the short dry season. This retardation increases rapidly during the break in the rains to reach a maximum of twenty per cent. at the end of the period. Thereafter, a gradual recovery takes place which continues until complete recovery has been attained just before senescence occurs. In the first investigation a minimum depression of twenty per cent. in the length of the monopodia was observed.

As a result of the depression and retardation of growth, flower production, and hence boll production and yield are reduced by from 25 to 35 per cent.

The heavy flower-bud shedding, that normally occurs with indigenous cotton before the cessation of the rains, is reduced by inter-cropping, as the development of the inter-cropped plants is both depressed and retarded at this time.

Inter-cropping increases the proportion of the crop born by the sympodia and decreases the proportion born by the monopodia. Thus the losses of crop occasioned by inter-cropping occur from the monopodia alone.

There is some evidence (during 1929–30 only), that inter-cropping slightly retards flowering and bolling. This retardation is of less than one week.

There is evidence that inter-cropping slightly reduces the mean maximum lint length. This reduction is too small to be of economic importance.

Inter-cropping does not affect :

(i) Shape of the plant (determined in 1928–29 only).
(ii) Boll shedding.
(iii) Mean boll weight.
(iv) Period of maximum delivery of the crop.

The data obtained from the study of ginning percentages is inconclusive.

The competitive effect of the yam does not extend beyond a radius of 3 ft.

Mr. J. K. Mayo, Agricultural Botanist, Northern Provinces, reports that the main feature of the last six months has been jassid attack in October. This attack varied in intensity in different districts, being worst on the Empire Cotton Growing Corporation farm at Daudawa. Jassids have done no noticeable damage in previous years. " D," the strain which was selected for multiplication two years ago, and is now found susceptible to jassid (it suffered severely at Daudawa) is being withdrawn. Several other Allen strains and two of the introduced varieties (Acala and Mesowhite) were noticeably susceptible and have been abandoned in the early (breeding plot) stages.

There are two hairy strains, U4 and A12, supplied by Mr. Parnell in 1928, under trial, and it might be thought that the multiplication of these could be proceeded with immediately. Commercial Allen, however, which is now a mixture of types, does not appear to be seriously affected as a whole by the jassids though individual plants can easily be found which have suffered badly this year. Neither U4 or A12 lint are able to command any premium at home over the commercial lint. These varieties are being tested this year (1930–31) for yield against commercial seed. The results are not yet available. In view, however, of the success of U4 in other parts of Africa, seed of two new strains derived from U4 has been obtained from the Empire Cotton Growing Corporation.

There is only one really jassid resistant strain (" C ") among the Allen selections and judging by the laboratory measurements and one broker's valuation on a roller-ginned sample (275 on) it should be a good one. Yield figures and the spinning test report are not yet available.

There is, however, another Allen strain (" L "), which, though not hairy or particularly resistant to jassids, has yielded well for two successive seasons, including this season of jassids, and has favourable brokers' and spinning reports.

The results of the spinning test arranged by the Empire Cotton Growing Corporation arrived in September. The control samples, and the varieties A12 and F285 were spun at 28's twist. The selected Allen strains, the varieties H21 and Mesowhite, and the spinners' control (Argentine), were spun at 36's twist. Of the three selected Allen strains D, J and L, the spinners say, " These are probably capable of spinning much finer yarn than 36's, say 50's or possibly 60's."

The brokers' valuations on these cottons agreed on the whole with the spinning test results. All the selected strains and the variety H21 were better than the commercial lint, L and H21 commanding premiums of 60 and 50 points respectively. The commercial lint commanded a premium of 100 points on American May futures (1930) and L 160 points. L is at least equal in yield to the commercial Allen even in a " jassid " season (L is not hairy) and may take the place of strain D which has been abandoned.

In the " middle Belt," where neither the American types of the Northern belt or Ishan of the Southern belt seem to succeed, Mr. Taylor has begun selection in the local cotton this season.

Mr. F. D. Golding, Senior Entomologist, has furnished the following report on the final results of his cotton work at Bode Sadu which terminated in March, 1930.

In the report for the six months ending December 31, 1929, an account was given of the initial stages of a cotton survey carried out at Bode Sadu in the North of the Ilorin Province. The yields and pests of Native cotton were compared with those of two types of Ishan A, multiplied at Ibadan and Ilorin respectively. The three cottons were grown on each of two 2¼-acre blocks about 1,400 yards apart; Block A consisted of good soil typical of the district and Block B of much poorer gravelly soil.

Cotton stainers were not very numerous on either block, but the Pentatomid bug, *Halydicoris scoruba*, Dall., was responsible for much damage to all three cottons on Block B, being more prevalent on the Ishans than on the Native.

Bollworm attack was similar to that of other years and there was no significant difference in the infestation of the various cottons. Jassid damage was prevalent on Native cotton in both Blocks in December, but both Ishans were very little affected. The Capsid bug, *Helopeltis bergrothi*, Reut., was the principal pest on native farms in the vicinity of Bode Sadu and was responsible for much damage to the shoots of the cotton (especially Ibadan Ishan) in Block B. Cotton plants growing under unfavourable conditions appear to be more liable to attack by this insect than are healthy vigorous individuals. Angular leaf spot and black-arm were prevalent in both Blocks in October and November; and, up to the middle of November, about one-third of the bolls shed of all cottons on Block B bore bacterial lesions, while in Block A about 45 per cent. of each Ishan and 33 per cent. of the Native were affected by this disease. A higher percentage of Native harvested bolls were affected by bacterial disease than of either Ishan.

Flower production, boll shedding and mummification, and yield are summarised in the table shown on the next page.

The cleanliness of the Ishan seed-cotton, which has also been observed in all surveys in the past, appears to be correlated with the greater tendency for boll shedding, in other words many bolls which would have produced stained lint had they persisted are abscissed on account of the susceptibility of this cotton to damage to the green bolls.

—	Block A.		Native.	Block B.		Native.
	Ibadan Ishan.	Ilorin Ishan.		Ibadan Ishan.	Ilorin Ishan.	
Total No. flowers per acre	192,020	144,760	150,530	93,040	108,860	141,600
Per cent. shed	40	45	28	38	49	34
Per cent. mummied	19	18	16	26	16	20
Per cent. harvested	41	37	56	36	35	46
Total No. bolls harvested per acre	78,880	53,710	84,600	33,530	38,460	64,470
Per cent. locks undamaged	66	72	56	49	53	25
Per cent. locks damaged by:						
Bollworms	17	15	18	17	20	18
Bugs	10	6	9	17	16	24
Bacteria	4	3	11	11	7	26
Unclassified	3	4	6	6	4	7
Yield per acre in lb. seed-cotton	319	230	317	116	123	200
Per cent. stained	5	6	17	17	12	55
Main non-experimental plots: yield per acre in lb. seed-cotton	281	214	315	112	121	188

On Block A, Ibadan Ishan gave a yield of greater value than the Native, but this year's results confirm those of the two previous years, viz. that there is not sufficient evidence of the superiority of Ishan over Native cotton in the Ilorin Province to warrant its replacing the indigenous variety. The conditions in that province appear to be unfavourable to Ishan which has been derived from a cotton grown in the Benin Province.

Kapok

Ceylon.—According to the Report of the Entomological Division of the Department of Agriculture for 1930, a new weevil pest of kapok (*Eriodendron anfractuosum*) was discovered during the year, and has been identified as *Alcides affaber*. Other species of this genus of weevils are known in Ceylon, but this species does not appear to have been noted previously in this island, although it is common in other parts of the East. So far, the attempts made to breed this weevil have not been successful, but further trials are to be made. In this connection it is of interest to note that a related species, *Alcides leeuweni*, is a serious pest of kapok in Java, and the Entomological Division was in communication with Java towards the end of 1929 as to whether this species occurred in Ceylon and whether it was known to have any parasites here. The reply was in the negative, but the subsequent discovery of *A. affaber* on kapok and of at least one parasitic enemy of this species has been communicated to Java.

RUBBER

Hevea

Ceylon.—The Mycological Division of the Department of Agriculture, Ceylon, reports that the severity of attack of Hevea mildew (*Oidium Heveæ*) has not appreciably altered. The disease has been less apparent in the Kandy district during 1930, but continues to be serious in other mid-country districts. It appears to be firmly established in the drier parts of the rubber-growing area such as Matale and Uva. The Mycologist of the Rubber Research Scheme has carried out extensive trials with finely divided sulphur in a power duster. The experiments are still in progress, but sufficient work has been done to show that sulphur dusting is a quick, effective and comparatively cheap means of control of *Oidium*. There remain one or two practical difficulties, which it is hoped will be solved in the near future. *Phytophthora* diseases have attracted little attention during the year. Root diseases have not been more severe than in previous years and their control is well in hand. Leaf diseases, other than those caused by *Phytophthora* and *Oidium*, have been fairly common but have caused little damage.

The increasing area planted in budded rubber is responsible for a new set of mycological problems. It was recorded in the Report for 1929 that diebacks of budded shoots associated with *Phytophthora* and with slug injury had occurred, and that bud shoots had been attacked by *Rhizoctonia Solani*, which had spread to the shoots from Vigna (*Dolichos Hosei*) that had been used as protective wrapping. Further records of the *Rhizoctonia* disease were received during 1930 and the parasitism of the *Rhizoctonia* has been proved by experiment. Lack of care in the treatment of stocks has also been responsible for the death of budded shoots. The common practice in Ceylon is to behead the stock when the bud shoot is well established and to leave the stump to die back to the union of stock and scion. The dead snag is either knocked off or is allowed to fall off, and little trouble is taken to protect the scar. An interesting example was received in which the dead stump had been knocked off some little way above the union and had left a jagged surface. *Ustulina zonata* had gained entrance at the snag and had spread beyond the point of union into the bud shoot, which it had killed.

It is very desirable that all stumps over two inches in diameter should be sawn off close to the union of stock and scion, and that the exposed surface should be protected with a coating of tar. Stumps less than two inches in diameter may be left to heal themselves with a fair measure of safety.

The Entomologist of the Department reports that in the majority of cases of rubber trees attacked by the termite *Coptotermes ceylonicus* there are present the symtoms of *Ustulina zonata*, and it would appear that woody tissue killed by *Ustulina* and not completely cleaned out may provide a means of entry for termites, which spread thence to healthy tissue and in many cases hollow out the tree so completely that it is blown over by the slightest breeze.

Experiments have been carried out during the year on the poisoning of trees. It is claimed for a proprietary fungicide that, if painted on the wood of a completely ringed tree, it will impregnate the roots and protect them from the attacks of fungi. If the claim is substantiated it will follow that the tree may be removed and the roots left in the ground without fear that they will serve as starting points for root-disease fungi. The results of the experiments may thus prove to be of importance to rubber estates that are considering rejuvenation, particularly in areas where root disease is common. The experiments are still in progress ; a rubber tree ringed and painted was killed in two months, a tree ringed but not painted is still alive after five months, as is also a tree in which auger holes nine inches deep in the trunk were filled with the poison.

An interesting example of fasciation following lightning injury was recorded. A three-year-old tree was pollarded in consequence of lightning injury. The first two shoots that developed displayed marked fasciation ; subsequent growth was normal. It would appear that abnormal development may occur as a result of severe shock.

TOBACCO

Ceylon.—According to the Report of the Mycological Division of the Department of Agriculture, Ceylon, for 1930, a beginning has been made on the study of the virus diseases of solanaceous crops. Mosaic disease of tobacco was chosen for immediate study and a survey of tobacco-growing areas of the North-Western Province was undertaken. The tobacco grown in these areas is entirely of a local variety, and the amount of disease seen was small. The commonest disease was bacterial wilt (*Bacillus solanacearum*), but it has not been known to affect large areas. A little mosaic and less leaf spot (*Cercospora Nicotianæ*) were found. The so-called mosaic disease appears to require thorough investigation. The incidence of the disease does not suggest the highly infectious nature attributed to it by other workers, nor has it been found on chillies or brinjal grown in the same field as the tobacco. A leaf-crumbling resembling mosaic was found on a weed (*Amarantus viridis*) growing in a tobacco plot, but no solanaceous weeds bearing symptoms of the disease were observed. It is possible that the disease here called mosaic is a different form from that recorded by other workers, or that it is merely a non-infectious chlorosis accompanied by crumbling of the leaves. Somewhat similar symptoms have been seen on plants attacked by stem borer (*Phthorimœa heliopa* Lower). Diseased specimens have been collected and inoculation experiments are being carried out.

MINERAL RESOURCES

CYPRUS

The Imperial Institute has received from the Colonial Secretary the following report by the Inspector of Mines on the progress of mining in Cyprus during the second six months of 1930:

Mining activities in the Colony were very adversely affected by the world depression in trade, which resulted largely in the curtailment of work in the operating mines with a decrease in the output of minerals.

Prospecting operations by the larger companies employing drilling methods were carried out uninterruptedly, but the results were not encouraging.

The following statistics refer to the development and exploitation of various mining companies:

Cyprus Mines Corporation—Skouriotissa Pyrites Mine

	Last 6 months 1930.	Last 6 months 1929.
Tonnage mined	93,814	134,696
Labour, underground only (average per day)	538	739
Tonnage exported	103,250	146,080
Labour, total surface and underground (average per day)	1,211	1,576

CYPRUS MINES CORPORATION—MAVROVOUNI PYRITES MINE

	Last 6 months 1930.	Last 6 months 1929.
Boreholes, footage sunk	2,022	2,073[1]
Boreholes, labour (average per day)	20	19
Development, total footage	3,706	3,262
Development, labour (average per day)	89	169
Tonnage mined	11,668	4,320
Labour, underground only (average per day)	340	389
Labour, all operations (average per day)	655	970

[1] *Please note, the figure* 4,786 *given in the* 1929 *report was incorrect.*

CYPRUS SULPHUR AND COPPER CO., LTD.—LYMNI PYRITES MINE

		Last 6 months 1930.	Last 6 months 1929.
Development, total footage		537	603
Labour, all operations (average per day)		70	34
Ore mined	*tons*	748	Nil

DEUTSCHE ORIENT GRUBEN GESELLSCHAFT—TROODOS CHROME IRON ORE MINES

		Last 6 months 1930.	Last 6 months 1929.
Development, total footage		384	181
Ore mined	*tons*	1,215	2,041
Labour (average per day)		47	45
Ore exported	*tons*	Nil	708

CYPRUS ASBESTOS CO., LTD.—AMIANDOS ASBESTOS MINE

		Last 6 months 1930.	Last 6 months 1929.
Rock mined	*tons*	413,077	1,185,016
Rock treated	*tons*	103,084	259,504
Finished asbestos produced	*tons*	4,964	9,479
Finished asbestos exported	*tons*	2,336	7,195
Labour, all operations (average per day)		901	4,090

OTHER MINERALS, EXPORTED BY VARIOUS PRODUCERS

		Last 6 months 1930.	Last 6 months 1929.
Terra umbra	*tons*	1,614	3,420
Terra verte	*tons*	15	3
Gypsum	*tons*	4,809	6,430
Building stone	*cubic yards*	230	197

FEDERATED MALAY STATES

The Imperial Institute has received a report from the Director of the Geological Survey of the Federated Malay States for the six months ended December 31, 1930:

The continued depression of the tin market resulted in enquiries being made about possible gold-mining, and especially gold dredging, but no operations were initiated. The Raub Australian Gold Mining Company, however, decided to reopen the old gold mine at Silensing, and there is a possibility of the Punjom mine being reopened also.

Another alleged occurrence of oil was reported in the Dindings, but a company interested in oil had the matter investigated with negative result, the Dindings being granite and recent alluvium.

Coal was found by a firm, by means of boring, in the railway reserve near Kluang, Johore, and while their work was in progress the Chinese manager of an adjacent rubber estate, while sinking a well, found a seam of black fuel 35 ft. thick, which contained 18·7 per cent. moisture and 21·5 per cent. ash. None of the fuel found in Kluang is of good quality, but there is now no doubt that coal does occur in Johore. The best specimen analysed gave the following results: Moisture, 3·76; volatile hydrocarbons, 33·80; fixed carbon, 44·60, and ash, 18·04 per cent.

The Mining Geologist, Dr. F. T. Ingham, found aurichalcite, allophane and jamesonite in Kinta during the course of his work. These minerals had not been recorded previously in Malaya.

Of the mineral specimens submitted for report the most interesting was a concentrate from Sungei Lebam, Johore, which consisted of ilmenite, tourmaline, staurolite, cassiterite, gold, zircon, quartz, andalusite, anatase and blue corundum. Staurolite has only been found in three localities.

NIGERIA

The Director of the Imperial Institute has received from Dr. R. C. Wilson, Director of the Geological Survey of Nigeria, the following report on the progress of geological research in Nigeria during the period July to December, 1930.

Gold.—The field study on the rocks of the Minna Birnin Gwari belt was concluded for the season with the mapping of the southern half of the Kusheriki sheet, and the petrological study of the specimens is being continued in the laboratory.

Lead.—The structures found in the Abakaliki area have been found to extend for considerable distances. The officer engaged on the work has proceeded to America on being awarded a Commonwealth Fund Fellowship and work will be discontinued until his return. He left England soon after his return from Nigeria, so that no laboratory work has been done on his specimens.

Coal.—The coal-bearing rocks were traced northwards and were later found to swing westerly, parallel to the Benue, but a considerable distance south of the river. Specimens from several of the seams were collected and are being analysed in the Imperial Institute laboratories. No fossils have been encountered that might lead to a precise determination of the age of these beds.

Water Supply.—The proposal that water-supply investigations be extended to Kano and Bornu Provinces has been approved, and while the Director has been in England, officers have been appointed and well-sinking equipment has been ordered to carry out the work. The geological structure of these areas is at present unknown, but preliminary investigations are proceeding from which sufficient information has been obtained to enable trial wells to be sunk. One well was put down at Malamaduri and one at Nguru, both of which have shown that water in promising quantities lies within reach.

Publications.—The vertebrate fossils collected from Sokoto and submitted to Mr. Swinton of the Natural History Museum, London, have been described by him and the results of his investigations have been published as *Bulletin No.* 13 *of the Geological Survey of Nigeria,* under the title : " On Fossil Reptilia from Sokoto Province."

NYASALAND

The Imperial Institute has received from Dr. F. Dixey, Director of the Geological Survey of Nyasaland Protectorate, an advance report on the department's work for the year 1930, from which the following notes have been extracted :

Field-work.—The itinerary for the year included the following visits and examinations: two visits to the Salambidwe area on the Anglo-Portuguese border, west of Chikwawa, where thin bands of coal were noted in the coal shales of the Ngona River ; to the North Nyasaland district to meet members of the British Museum East Africa Expedition ; to the Tambani corundum area where the presence of graphite was recorded ; to the Chirudzulu and Mlanje districts, the Chilwa-Tuchila plain and the Lower Shire area, in connection with water supply, including the well-sinking programme for 1931 and with earlier authorised work being completed ; to Lake Malombe for the collection of clay samples for examination for cement-making ; to the Ncheu district to visit various mica and asbestos deposits and to the Shire Highlands near Zomba and towards Fort Lister, several visits being made, where rapid traverses were carried out in connection with the general survey.

Colonial Development Schemes.—Schemes were prepared for the consideration of the Advisory Committee of the Colonial Development Fund under :

(1) Intensive Geological Survey,
(2) Water Supply Investigation,

with the result that a £21,030 grant was received towards the latter, but consideration of the former was deferred.

Geological Survey Scheme.—The scheme, which accompanied the 1931 estimates, explained that the Geological Survey was understaffed and important work was consequently delayed, and recommended the provision for five years of three geologists and equipment at a cost of £15,295.

Water Supply.—The scheme provided for a geologist in general charge; assistance at headquarters; two Europeans to supervise the sinking of wells; a portable steam-driven water-boring plant; minor well-sinking plant, and materials. The funds supplies were, for a period of five years and covered capital expenditure, £4,030, and an annually recurring running expense of £3,420.

The following work was provided for in the programme: well-sinking and boring in the northern part of the Chirudzulu district of the Shire Highlands, the sinking of a group of wells near Port Herald in the Lower Shire district as well as wells in other districts.

The provision of water supply in dry and hitherto uninhabited districts will be the means of the attracting there of population from densely-peopled areas such as the Port Herald, Chirudzulu and Zomba districts, and, in some cases, for instance, the Chikwawa and Lower Shire districts, valuable agricultural land will be developed.

In the Lilongwe district, where sub-soil water-supply conditions are remarkably constant, well-boring will provide a number of small perennial supplies and be the means of encouraging settlement.

During the year special reports were made to the Medical and Public Works Departments on the water-supply conditions of Limbe and to the Forestry Department as to areas suitable for forest conservation for the maintenance of water supplies.

Laterite.—The conditions under which laterite deposits are developed in Nyasaland have been studied and described, especially those at the foot of Salambidwe Hill, west of Chikwawa, and on the Mlanje and Zomba Mountains. In certain cases laterite is useful as a road material. Its more ferruginous varieties are used in Nyasaland by native iron smelters. In places such as Chilwa Island, Tundulu Hill and Kangankunde Hill, there occur dark-brown or black manganiferous laterites.

Zambesi Bridge Site.—The Director of the Survey, in connection with the Zambesi Bridge site, discussed with the General Manager of the associated railways and the Engineer in charge the value of the building materials to be used, the nature of the foundations as revealed by boreholes and, later, submitted a report on the security of the site from earthquake disturbances.

Nyika Plateau.—This plateau in North Nyasa, much of which is over 7,000 ft. in altitude, was investigated, and some economic minerals were observed, including deposits of *bauxite* and *iron ores* at the north end, all too thin to be of value, and *manganiferous schists* near the Rumpi Valley. The iron ore native workings which were found in the area are evidence of a former industry.

Fossil Mammalian Remains.—A report by Mr. A. T. Hopwood, of the Department of Geology, British Museum, on fossil remains from Pliocene formation at Uraha Hill, North Nyasa, showed them to be parts of varieties of the following types : Hippopotamus, Giraffa, Hylochœrus and Elephas.

Stone Implements.—Of a collection of eleven stone implements found in the outcrop of the Chitimwe Beds on the north-west shores of Lake Nyasa and sent to Mr. Wayland, Director of the Geological Survey of Uganda, for verification, two were judged to be undoubted, and eight, probably, artifacts.

British Museum and East Africa Expedition.—The expedition visited Nyasaland during the year with the object of collecting fossil remains from the Dinosaur Beds between Florence Bay and Karonga, on the north-west shore of the lake.

Miscellaneous Minerals.—Small deposits of *corundum* have been leased at Tambani Hill, Central Shire district. In association with these, deposits of *zircon* may possibly be worked also. *Talc-schist* noted in the Mwanza district was similar to that in the Ncheu area with which *asbestos* is associated, so that asbestos may possibly be found also in the former area. Low-grade ferruginous *manganese ore* was observed on the outcrop of the manganiferous schists along the east bank of the Rumpi River. A promising deposit of *mica* was found near Njuyi Hill about 16 miles south of Ekwendeni in the Mombera district and grey *crystalline limestone* on the Zomba-Mlanje road, south of the Palombe crossing.

UGANDA

The Imperial Institute has received from the Director of the Geological Survey of Uganda the following short report of the work carried out during the half year ended December 31, 1930 :

Field work begun during the first half of the year was continued in the Budama and Bugishu districts of the Eastern Province. Further limestone deposits have been discovered and the area which includes the Bugishu series was mapped in detail. A large number of concentrates taken from the stream beds in the area are awaiting examination.

Further work was done upon the geology of the tin lodes in Ankole and the Field Geologist completed his writing of the memoir on the geology of that area, and also of the Bufumbira volcanic area.

A further search for evidence of events in the later geological history of Uganda, more especially for the purpose of finding alluvial tin in South-Western Uganda, was carried out by the Director.

In the course of an inspection of the abandoned workings of the bismutotantalite occurrence at Gamba Hill, large masses of amblygonite were found. This lithium-bearing silicate had not previously been found in Uganda.

Private prospecting was on the whole not so active in Uganda as in the few previous years, but the tin-bearing areas in Ankole were further intensively prospected. The amount of tin ore exported during the year from the mines in Uganda was 363½ tons. The copper deposits at Kilembe, Toro, were still being prospected, though production has not yet commenced.

Geological advice was given to the Public Works Department water-boring section in connection with the drilling operations being carried out in Usuku in the Soroti District of the Eastern Province.

The work in the Seismological Observatory has been continued, though delay in the submission of the quarterly reports to the Seismological Committee of the British Association was experienced owing to shortage of and illness of staff. Two seismometers have been installed in the new and improved observatory erected to house them, and both instruments are now recording.

Further details of the work of 1930 will be found in the *Annual Report of the Geological Survey of Uganda* for that year, which is now in the Press.

The following publications were issued during the year: *Annual Report of the Geological Survey for the Year* 1929, price Shs. 3/25, including postage; *Summary of Progress of the Geological Survey of Uganda for the Years* 1919–1929, price Shs. 4/30, including postage; The following map was published: *Geological Map of the Bufumbira Lava Field and Adjacent Country*, price Shs. 4/25, including postage.

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AGRICULTURE

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Manufacture of Insulating Board from Cornstalks. By O. R. Sweeney and W. E. Emley. *Misc. Pub. No.* 112, *Bureau of Standards, U.S. Dept. Commerce.* Pp. 27, 9½ × 6. (Washington, D.C.: U.S. Government Printing Office, 1930.) Price 10 cents. Gives data about the location and quantities of cornstalk available, the physical and chemical composition of stalks, etc., and methods and cost of harvesting and packing. Describes experiments in the manufacture of board and gives estimated costs of production.

Étude sur le Développement du Chanvre (*Musa textilis*) cultivé à l'Aide de Produits Chimiques. By M. M. Peyronnet. *L'Agric. Prat. des Pays Chauds* (1931, **2**, 309–316).

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Annual Report on the Sericultural Operations, Burma, for the Year Ended 31st March, 1930. Pp. 6, 9¾ × 6. (Rangoon: Superintendent, Government Printing and Stationery, 1930.) Price As.4 or 5*d.*

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Die Wirtschaftslage der Sisalfasern. By J. H. H. Roff. *Faserforschung* (1931, **9**, 63–71). The economic position of sisal fibre.

Machines à Défibrer le Sisal. By G. Passelègue. *Agron. Col.* (1931, **20**, No. 157, 1–7).

Report of the Proceedings of the Imperial Wool Research Conference, 1930, at London, Leeds and Edinburgh. *Empire Marketing Board Publication.* Pp. 101, 9¾ × 7½. (London: H.M. Stationery Office, 1931.) Price 1*s.*

La Laine du Mouton " Awas " de Syrie. Comparaison avec d'Autres Races. Amélioration—Transhumance. By A. Porcherel and M. Cordaillat. *L'Agron. Col.* (1931, **20**, 33–36; 76–86; 109–115).

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The Effect of Topping Egyptian Cotton Plants. By J. Templeton. *Bull. No.* 103, *Bot. Sect., Tech. and Sci. Serv., Min. Agric., Egypt.* Pp. 9, 10½ × 7¼. (Cairo: Government Press, 1931.) Price P.T. 3.

Notes on Indian Cottons. By A. J. Turner. *Agric. Journ., India* (1930, **25**, 487–491). Descriptions of various cottons and their production and yield.

Cotton Growing in India in Relation to Climate. By T. Trought and Mohammad Afzal. *Mem. Dept. Agric., India, Bot. Ser., Vol. XVII, No.* 5. Pp. 20, 9¾ × 7¼. (Calcutta: Government of India Central Publication Branch, 1930.) Price As. 12 or 1*s.* 3*d.*

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Methods of Ginning in Relation to the Grade and Staple of Cotton. By D. T. Killough and G. T. McNess. *Bull. No.* 416, *Texas Agric. Exper. Sta.* Pp. 32, 9 × 6. (Brazos County: State College, 1930.)

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A Short Note on the Diseases of Cotton Seedlings in the Central Provinces. By Jehangir Fardunji Dastur. *Agriculture and Livestock in India* (1931, **1**, 44–48).

Paper-making Materials

Some New Processes for the Separation of Fibrous Cellulose from Plant Substances. By J. M. Arnot. *World's Paper Trade Rev.* (1931, **95**, 961–964).

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Ninth Annual Report of the Rubber Research Scheme (Ceylon). Pp. 50, 10¼ × 8. (Ceylon: Rubber Research Scheme, 1931.)

Budding in the Field at Peradeniya. By T. H. Holland. *Trop. Agric., Ceylon* (1930, **76**, 4–12).

Control of Mouldy Rot Disease of Rubber. By F. Beeley. *Malayan Agric. Journ.* (1931, **19**, 74–76).

The Hydrogen Ion Concentration of Hevea Latex. By N. H. van Harpen. *Rubber Series No.* 80, *Communications from the General Exper. Sta., A.V.R.O.S.* Pp. 67, 10½ × 7¼. (Buitenzorg: Archipel Drukkerij, 1931.) Reprinted from *Arch. v.d. Rubbercultuur*, Vol. XV, No. 1, January 1931.

Preparation of Sheet Rubber. By R. O. Bishop. *Malayan Agric. Journ.* (1931, **19**, 14–21).

Een Niew Procédé voor Sheetrubberbereiding. A new Process for the Manufacture of Sheet Rubber. By N. H. van Harpen. *Med. van het Alg. Proefsta., A.V.R.O.S., Rubberserie No.* 79. Pp. 24, 10¾ × 7¼. (Buitenzorg: Archipel Drukkerij, 1930.) In Dutch and English.

Report on Sulphur Dusting Experiments on Gonakelle Estate. Contributions from the Rubber Research Scheme, Ceylon. By R. K. S. Murray. *Trop. Agric., Ceylon* (1931, **76**, 13–17).

Tobacco

Tobacco Culture. By W. W. Garner. *Farmers' Bull. No.* 571, *U.S. Dept. Agric.* Pp. 22, 9 × 5¾. (Washington, D.C.: U.S. Government Printing Office, 1930.) Price 5 cents. Deals with the cultivation and diseases of various types of tobacco.

La Culture du Tabac en Algérie. By L. Ducellier. *Rev. Bot. Appl. et d'Agric. Trop.* (1931, **11**, 108–114). Deals mainly with the industry and quality of Algerian tobacco.

Grondslagen en Resultaten der Tegenwoordige Veredeling bij de Vorstenlandsche Tabak. By D. Tollenaar and H. A. Middelburg. *Med. No.* 63, *Proefsta. voor Vorstenlandsche Tabak, Ned.-Indië.* Pp. 88, 10½ × 7¾. (Buitenzorg: Departement van Landbouw, 1930.) With summary in English. Deals with the principles and results of recent tobacco-breeding in the Vorstenlanden.

The Germination of Tobacco Seed. By J. Johnson, H. F. Murwin and W. B. Ogden. *Res. Bull.* 104, *Wisconsin Agric. Exper. Sta.* Pp. 15, 9 × 6. (Madison: University of Wisconsin, 1930.) Study of the conditions of germination.

Flue-Curing of Tobacco. By W. R. Thompson. *Bull. No.* 88, *Dept. Agric., Un. of S. Africa.* Pp. 12, 9½ × 6. (Pretoria: Government Printer, 1930.) Price 3*d.*

Potash Fertiliser Experiments with Tobacco. *Bull.* 311, *Connecticut Agric. Exper. Sta., Report of the Tobacco Substation at Windsor, Connecticut, for* 1929, pp. 207–215.

Chemical Composition of a Poor Burning Tobacco Crop Compared with a Good Burning Crop. By E. M. Bailey and P. J. Anderson. *Bull.* 311, *Connecticut Agric. Exper. Sta., Report of the Tobacco Substation at Windsor, Connecticut, for* 1929, pp. 228–233.

Chemical Investigations of Tobacco. By H. B. Vickery and G. W. Pucher. *Bull.* 311, *Connecticut Agric. Exper. Sta., Report of the Tobacco Substation at Windsor, Connecticut, for* 1929, pp. 234–246.

Field Experiments on Brown Root-rot of Tobacco. By H. F. Murwin, G. P. Clinton and P. J. Anderson. *Bull.* 311, *Connecticut Agric. Exper. Sta., Report of the Tobacco Substation at Windsor, Connecticut, for* 1929, pp. 247–255.

Drugs

Sixty-Eighth Annual Report of the Government Cinchona Plantations and Factory in Bengal for the Year 1929–30. Pp. 25, 9¾ × 6¼. (Calcutta: Bengal Secretariat Book Depot, 1930.) Price 9 annas or 1*s.*

Der Kokastrauch und seine Kultur in der " Monta " sowie über die Kokaverwendung in Peru. By J. Wille. *Tropenpflanzer* (1931, **34**, 99–109). The cultivation of the coca plant and production of cocain in Peru.

Indian Ephedras. By S. Krishna and T. P. Ghose. *Indian For. Records*, 1931, *Vol. XVI, Chem. Series, Part II*, pp. 19–50.

Papaya Cultivation in the Bombay Presidency (excluding Sind). By G. S. Cheema and P. G. Dani. *Bull. No.* 162 *of* 1930, *Dept. Agric., Bombay.* Pp. 22, 9½ × 6. (Bombay: Superintendent, Government Printing and Stationery, 1930.) Price As. 3 or 4*d.* An excellent account of the propagation, cultivation, pests and diseases, marketing and the extraction of papain.

La Papaye. By L. Y. Leonard and P. G. Sylvain. *Bull. No.* 20, *Serv. Technique du Départ. de l'Agric., Haiti.* Pp. 28, 9¼ × 6¼. (Port-au-Prince, Haiti: Service Technique du Département de l'Agriculture, 1930.) Account of varieties, of papaya cultivation, and preparation of papain.

Miscellaneous Agricultural Products

Bees and Bee-keeping. By A. E. Ophel. *Journ. Dept. Agric., S. Australia* (1931, **34**, 645–652).

Furfural and Its Industrial Applications. By T. Hedley Barry. *Indust. Chem.* (1930, **6**, 479–481).

The Commercial Production of Glucose. By A. E. Williams. *Indust. Chem.* (1930, **6**, 495–499).

Livestock and Animal Products

Annual Administration Reports of the Bombay Veterinary College, Bombay City and Harbour Veterinary Department and Civil Veterinary Department in the Bombay Presidency (including Sind) for the Year 1929–30. Pp. 58, 9¾ × 6. (Bombay: Superintendent Government Printing and Stationery, 1930.) Price Annas 4 or 5*d.*

Annual Report of the Livestock Research Station, Guntur, Madras, for the Year 1929–30. By R. W. Littlewood. Pp. 10, 9¾ × 6. (Madras: Superintendent, Government Press, 1931.)

Annual Report of the Livestock Research Station, Hosur, Madras, for the Year 1929–30. By R. W. Littlewood and T. Murari. Pp. 22, 9¾ × 6. (Madras: Superintendent Government Press, 1931.)

Annual Report of the Veterinary Department, Northern Provinces, Nigeria, for the Year 1929,. Pp. 84, 13¼ × 8. (Lagos : C.M.S. Bookshop.) Price 5*s.* 6*d.*

Sixteenth Report of the Director of Veterinary Services and Animal Industry, Onderstepoort, Pretoria, August 1930. Pp. 592, 9½ × 7¼. (Pretoria : Government Printer, 1930.) Price 10*s.*

Report of the Chief of the Bureau of Animal Industry, United States Department of Agriculture. Pp. 79, 9 × 6. (Washington, D.C. : U.S. Government Printing Office, 1930.) Price 10 cents.

Report of the Chief of the Bureau of Dairy Industry, United States Department of Agriculture. Pp. 44, 9 × 6. (Washington, D.C. : U.S. Government Printing Office, 1930.)

An Economic Study of Range Sheep Production in Arizona. By K. P. Pickrell and E. B. Stanley. *Bull. No.* 134, *Arizona Agric. Exper. Sta.* Pp. 33, 9 × 6. (Tucson : University of Arizona, 1930.)

The Sheep Industry of Southern Rhodesia. By E. N. S. Warren. *Rhodesia Agric. Journ.* (1931, **28**, 135–141). The present position and the future of sheep farming in Southern Rhodesia and various recommendations.

Sheep Production in California. By R. F. Miller. *Circ.* 49, *California Agric. Extension Serv.* Pp. 66, 9¼ × 6. (Berkeley : University of California, 1930.) A survey of the sheep industry in California, a description of the varieties and the care and organisation of sheep farms.

Notes on the Preparation of Hides and Sundries for Export. *Circ. No.* 12, *Kenya Veterinary Dept.* Pp. 4, 13 × 8. Mimeographed copy.

Annual Report of the Fisheries of New South Wales for the Year 1929. Pp. 16, 13 × 8¼. (Sydney : Government Printer, 1930.) Price 1*s.* 1*d.*

Report on the Marine Fisheries of the Baroda State in 1930 with Suggestions for Their Future Developments. By J. Hornell. *Bull. No.* 30, *Dept. Commerce, Industries and Labour, Baroda State.* Pp. 22, 13 × 8¼. (Baroda State Press, 1930.) Price Re. 1.

Report of an Investigation into the Cyprus Sponge Fishing Industry. By L. R. Crawshaw. Pp. 30, 13 × 8. (Nicosia : Government Printing Office, 1930.) Price 15 piastres or 1*s.* 8*d.*

FORESTRY

General

Progress Report of the Imperial Forest College, Dehra Dun, India, for the Year 1929–30. Pp. 29, 9¾ × 6¼. (Calcutta : Government of India Central Publication Branch, 1931.) Price Re. 1–8 or 2*s.* 6*d.*

Progress Report of Forest Administration in the Province of Assam for the Year 1929–30. Pp. 79, 13¼ × 8½. (Shillong : Assam Government Press, 1930.) Price Re. 1–15 or 2*s.* 11*d.*

Report of Forest Administration in Baluchistan for the Year 1929–30. Pp. 44, 9½ × 6¼. (Calcutta : Government of India Central Publication Branch, 1931.) Price Rs. 5–12 or 9*s.* 6*d.*

Report on Forest Administration in Burma (excluding the Federated Shan States) for the Year Ending March 31, 1930. Pp. 282, 9¾ × 6¼. (Rangoon : Superintendent, Government Printing and Stationery, 1931.) Price Rs. 5 or 7*s.* 6*d.*

Report on the Forest Administration in the Utilisation Circle, Burma, for the Year Ending March 31, 1930. Pp. 68, 9¾ × 6½. (Rangoon : Superintendent, Government Printing and Stationery, 1930.) Price Rs. 3 or 4*s.* 6*d.*

Annual Report on Working Plans and Silviculture in Burma for the

Year 1929–30. Pp. 74, 9½ × 7½. (Rangoon: Superintendent, Government Printing and Stationery, 1931.) Price Rs. 2 or 3*s*.

Progress Report of the Forest Administration in Coorg for 1929–30. By H. G. Hicks. Pp. 59, 9¾ × 6½. (Bangalore: Mysore Residency Press, 1930.) Price, Re. 1.

Progress Report on Forest Administration in the Punjab for the Year 1929–30. Pp. 141, 9¾ × 6¾. (Lahore: Superintendent Government Printing, 1930.) Price Rs. 6–12–0 or 10*s*. 2*d*.

Annual Progress Report of Forest Administration in the United Provinces for the Period April 1, 1929, to March 31, 1930. Pp. 126, 9¾ × 6½. (Allahabad: Superintendent, Government Press, 1930.) Price Rs. 4–8.

Nos Bois Coloniaux. By J. Méniaud. *Bull. de l'Agen. Gén. des Col.* (1930, **23**, 901–964; 1037–1175; **24**, 3–172). An exhaustive study of French Colonial woods; the study of the forest resources and state of the industry in various colonies and the woods suitable for various purposes. Each wood is also dealt with separately, a description of the tree being given and also the character and uses of the wood.

Etude sur les Principaux Arbres et Arbustes d'Haiti Propres à l'Ornementation. By P. G. Sylvain. *Bull. No.* 21, *Serv. Tech., Dept. Agric., Haiti.* Pp. 57, 9¼ × 6¼. (Port-au-Prince, Haiti: Service Technique, 1930.)

Annual Report of the Director of Forestry of the Philippine Islands for the Fiscal Year Ended December 31, 1929. Pp. 295, 9¼ × 6. (Manila: Bureau of Printing, 1930.)

Forest and Range Resources of Utah, their Protection and Use. *Misc. Pub. No.* 90, *U.S. Dept. Agric.* Pp. 101, 9¼ × 6. (Washington, D.C.: U.S. Government Printing Office, 1930.) Price 30 cents.

Illustrations of Indian Forest Plants. Part II. Five Species of Dipterocarpus. By R. N. Parker. *Indian Forest Records, Botany Series, Vol. XVI, Pt.* 1. Pp. 16 + x plates, 9¾ × 7. (Calcutta: Government of India Central Publication Branch, 1931.) Price Re. 1 or 1*s*. 9*d*. Consists of descriptions and illustrations of the plants.

Queensland "Maple" (*Flindersia* spp.). By M. B. Welch. *Tropical Woods* (1931, No. 25, 18–23). A detailed description of the tree and the wood and its uses.

Le Pe-Mou (*Fokienia Hodginsii*). *Bull. Econ., Indochine* (1930, **33**, 915B–924B). Description and sylviculture of the tree.

Note sur *Gmelina arborea* Roxb., Essence de Repeuplement pour la Forêt Tropicale Asiatique. By D. Normaud. *Rev. Bot. Appl. et d'Agric. Trop.* (1931, **11**, 168–174). Description of the tree, its wood and uses.

Establishing Pines. Preliminary Observations on the Effects of Soil Inoculation. *Rhodesia Agric. Journ.* (1931, **28**, 185–187).

The Regeneration of the Sal in the United Provinces. By M. D. Chaturvedi. *Indian Forester* (1931, **57**, 157–166).

Suggestions for the Management of Spruce Stands in the North-East. By M. Westveld. *Circ. No.* 134, *U.S. Dept. Agric.* Pp. 23, 9 × 6. (Washington, D.C.: U.S. Government Printing Office, 1930.) Price 10 cents.

Some Shade-Tree Pests and Their Control. By G. W. Herrick. *Bull.* 515, *Cornell University Agric. Exper. Sta.* Pp. 26, 9 × 6. (Ithaca, New York: Cornell University, 1931.) Deals with the pine-leaf scale (*Chionaspis pinifoliæ*), magnolia scale (*Neolecanium cornuparvum*), maple bladder-gall mite (*Phyllocoptes quadripedes*), and the spruce gall aphid (*Adelges abietis*).

White Pine Blister Rust Control in Connecticut. By J. E. Riley. *Bull.* 314, *Connecticut Agric. Exper. Sta.* Pp. 23, 9 × 6. (New Haven: Agricultural Experiment Station, 1930.)

Timbers

Summary of Information on the Chief Timbers of Burma. *Burma Forest Bull. No.* 22, *Econ. Series, No.* 4. Pp. 8, 9¾ × 6¼. (Rangoon: Superintendent, Government Printing and Stationery, 1931.) Price As. 2 or 2*d*.

The Distribution and the Mechanical Properties of Alaska Woods. By L. J. Markwardt. *Tech. Bull. No.* 226, *U.S. Dept. Agric.* Pp. 79, 9 × 6. (Washington, D.C.: U.S. Government Printing Office, 1931.) Price 20 cents.

Properties of African Olive (*Olea Hochstetteri* Baker). Investigation 7. Preliminary Tests on Timbers, Investigated under the Auspices of the Empire Timbers Committee. *Project* 22, *For. Prod. Res. Laboratory, Dept. Sci. Indust. Res.* Pp. 37, 9½ × 7½. (Princes Risborough: Forest Products Research Laboratory, 1931.)

The Rate of Growth and Density of the Wood of White Spruce. By J. D. Hall and K. S. Fensom. *Circ. No.* 30, *Forest. Serv., Dept. Inter., Canada.* Pp. 19, 9¾ × 6½. (Ottawa: King's Printer, 1931.)

Strength and Characteristics of Wood Used in Aircraft Construction. By G. W. Trayer. *Proc. American Soc. for Testing Materials, Vol.* 30, 1930, *Part II, Technical Papers*, pp. 48–57.

Use of Amaranth or Purpleheart (*Peltogyne pubescens* Benth.) for Interior Trim and Flooring. By H. S. Clark. *Tropical Woods* (1931, No. 25, 1–3).

Strength Tests of Creosoted Douglas Fir Railway Ties. By J. F. Harkom and J. B. Alexander. *Circ. No.* 29, *Forest. Serv., Dept. Inter., Canada.* Pp. 15, 9¾ × 6½. (Ottawa: Department of the Interior, 1931.)

The Use of Home-Grown Larch Poles for Transmission Lines. *Bull. No.* 8, *Forest Prod. Res., Dept. Sci. Indust. Res.* Pp. 25, 9¾ × 7¼. (London: H.M. Stationery Office, 1931.) Price 2*s*.

The Strength of Telephone Poles. Eastern Cedar, Red Pine and Jack Pine. By G. H. Rochester. *Circ.* 31, *Forest Serv., Dept. Inter., Canada.* Pp. 16, 9¾ × 6½. (Ottawa: King's Printer, 1931.)

The Testing of Timber for Moisture Content. By I. H. Boas. *Trade Circ. No.* 2, *Div. Forest Prod., Counc. Sci. Indust. Res., Australia.* Pp. 8, 9½ × 6. (Melbourne: Government Printer, 1930.) The description of a simple method.

Changes in Moisture Content of Kiln-Dried Lumber when Shipped by Rail. By J. H. Jenkins. *Circ.* 32, *Forest Serv., Dept. Inter., Canada.* Pp. 6, 9¾ × 6½. (Ottawa: King's Printer, 1931.)

The Death-Watch Beetle (*Xestobium rufo-villosum*). *Leaflet No.* 4, *Forest Prod. Res., Dept. Sci. Indust. Res.* Pp. 5, 9¾ × 7¼. (London: H.M. Stationery Office, 1931.) Life-history, damage and control of the beetle.

Gums and Resins

The Nature of the Resins in Jack Pine (*Pinus Banksiana*). By H. Hibbert and J. B. Phillips. *Canadian Journ. Res.* (1931, **4**, 1–34).

The First Ecdysis of the Lac Insect. By S. Mahdihassan. Pp. 12, 8½ × 5½. Reprinted from *Deutsch. Ent. Zeitschr.*, 1930. A study of the anatomical characters of the first and second stage larvæ for the purpose of early recognition of sex.

The Metamorphosis of the Male Lac Insect. By S. Mahdihassan. Pp. 10, 9 × 6. A description of the various moults of the male coccid.

Le "Loko," Gomme-Laque Blanche de Madagascar. By F. Heim de Balsac, G. S. Dagand and H. Heim de Balsac. *Bull. de l'Ag. Gen. des Col.* (1931, **23**, 411–428). A detailed description of the insect producing the lac, the character, composition and preparation of the lac.

Tanning Materials

L'Apport des Colonies et des Possessions Françaises en Matières Tannantes. By M. Martelli. *Actes et Comptes Rendus de l'Assoc. Col.-Sci.* (1931, **7**, 1–6; 34–40; 59–71). A survey of the tanning materials of the French Colonies.

A Bibliography of Papers on the Physical Properties of Leather. By C. H. Spiers. *Journ. Intern. Soc. Leather Trades' Chemists* (1931, **15**, 61–67).

NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

Nelson's Geography of the West Indies and Adjacent Lands. By J. O. Cutteridge, F.R.G.S. Pp. 327, 7½ × 5. (London, Edinburgh, New York, Toronto and Paris: Thomas Nelson & Sons, Ltd., 1931.) Price 2*s*. 8*d*.

The author of this handy volume, who is Assistant Director of Education and Chief Inspector of Schools in Trinidad and Tobago, has aimed at producing a concise modern geography for the requirements of students in the West Indies and adjacent countries. In his preface he expresses the hope that the work will also prove useful to teachers and pupils in other parts of the Empire, and this will undoubtedly be the case, as it contains a large amount of information in a small compass and can be recommended to all requiring a general geographical survey of the area with which it deals. The book describes not only the West Indian Islands themselves, but gives short accounts of the Guianas, Venezuela, Colombia, the Central American States, Mexico and Florida; and it concludes with a short section on the commercial relations of the West Indies with other parts of the world.

Indian Industry: Yesterday, To-day and To-morrow. By M. Cecile Matheson. Pp. xiv + 227, 7½ × 5. (London: Humphrey Milford, Oxford University Press, 1930.) Price 3*s*.

This well-written volume, issued under the auspices of the National Christian Council of India, Burma and Ceylon, is designed to give reliable information on the present conditions of labour and industry in India. The principal branches of industry dealt with are those relating to cotton, jute, coal-mining and tea. The economic and sociological aspects of labour conditions are described at considerable length, and suggestions made for possible improvements which might be effected by suitable supervision and regulation. The book is worth careful perusal by those concerned in administration or otherwise interested in the economic conditions and industrial problems of India.

LA CRISE ÉCONOMIQUE EN AFRIQUE BELGE. By Georges Van der Kerken. Pp. xii + 109, 9½ × 6¼. (Brussels: Établissements Émile Bruylant, 1931.) Price 25 francs; abroad, 30 francs or 6 belgas.

The author of this pamphlet is a distinguished Belgian authority on Colonial matters, and his treatise, although referring specially to the Belgian Congo, is worthy of attention by economists and administrators concerned in African conditions elsewhere in their relation to the present state of world commerce and industry. Despite the adverse factors at present affecting the Congo the author is optimistic as regards the future, and (to quote his concluding words) expresses " the conviction that Belgian Africa, if well and wisely governed, will one day become one of the most important producing and consuming countries of the world."

FIELD EXPERIMENTS IN HORTICULTURE. By T. N. Hoblyn, Dip. Hort. (Wye). Imperial Bureau of Fruit Production, Technical Communication No. 2. Pp. 50, 9½ × 7¼. (East Malling, Kent: Imperial Bureau of Fruit Production, 1931.) Price 2*s*.

During recent years much progress has been made in the technique of field experiments on annual crops, whereby factors such as soil variability, for example, can be allowed for and greater precision and reliability obtained. In horticulture the task is more difficult. The number of plants to an acre is comparatively few; they have to occupy the land for long periods and so an experiment already started cannot be lightly abandoned and another on a new method substituted. There is also the great difficulty of obtaining uniformity in the material used for the experimental work. In this paper Mr. Hoblyn deals with the improvement effected in material during recent years, reviews the methods of field experimentation, and discusses the application of modern methods, particularly to deciduous fruit trees, but with reference also to the difficulties met with by workers on tropical and sub-tropical tree crops.

An extensive bibliography concludes a publication which should prove both useful and stimulating to all engaged on horticultural investigations.

THE COCOA INDUSTRY OF TRINIDAD. Report by S. M. Gilbert, B.Sc. (Agric.), N.D.A., Dip. Agric. (Wye), Assistant Director of Agriculture, based on the recent Economic Survey. Trinidad and Tobago Council Paper No. 4 of 1931. Pp. 31, 19 figures and diagrams, 2 graphs, 3 maps and 8 appendices. (Port of Spain: Government Printing Office, 1931.) Price 2*s.* 6*d.*

This very detailed report on the cocoa industry of Trinidad is based on the results of a survey carried out by teams of practical planters, under the supervision of the Department of Agriculture in 1930.

The total acreage of the colony actually under cocoa is given as 209,000 acres, or 16,637 estates, using the word " estate " to denote a holding of any size. Whilst 63 per cent. of the estates are returned as good, 18 and 19 per cent. respectively are classed as medium and bad. The shortcomings of the industry are indicated. Over 30,000 acres have been abandoned, due to planting in unsuitable areas. Cultivation is generally poor, as also management and supervision ; one weak point is the very large number of owners, resident in the colony, who do not live on their properties. The factors affecting the industry are divided into those beyond the planters' control, e.g. low prices, and those which they can influence, e.g. selection of suitable land, more efficient supervision and better work generally. Recommendations are made whereby improvements may be effected. The author's general idea of the prospects of the industry is indicated thus : " Although the future will see keen competition, the writer maintains that an efficient cocoa planter on good soil, with access to cheap capital, can continue to make cocoa pay in Trinidad even at a small increase over present prices. Eventually, however, it will probably be only the industrious, educated and thrifty peasant proprietor, depending solely on his family for labour, and almost self-supporting as regards food, who will survive, plus possibly a few well financed, well equipped and well managed large estates."

A 21 YEARS' CHRONOLOGY OF TEXTILES, 1910–1931. Pp. 67, 11½ × 8½. (Manchester : Textile Institute, 1931.) Price 5*s.*

It is pointed out in the Introduction to this interesting volume that it has been prepared for issue in association with the Coming-of-Age Celebrations of the Textile Institute. It is a record of events, inventions and steps in the progress of the textile industry in this country during the past twenty-one years, and the fact that it has been compiled by the Editorial Staff of the Institute, from information supplied by over two hundred organisations, firms and members, suggests that there can be little of importance omitted from the history.

The subject-matter of the volume is arranged chronologically under nine headings, the first dealing appropriately with the history of the Textile Institute, whilst the second puts the activities of the textile world in a proper setting by chronicling the more important events of contemporary history. Then follow sections dealing respectively with fibres and their production ; yarns and their production ; fabrics and their production ; bleaching, dyeing and printing ; testing and analysis ; textile economics and welfare ; and finally textile research and education. The sections on fibres and their production, and on testing and analysis, consist largely of references to literature and form a useful bibliography of the outstanding papers on these subjects published since 1910. A tenth section giving textile and general statistics is not included in the volume, but is issued as a separate supplement.

The volume is very well illustrated, and contains photographs of persons eminent in the textile world and illustrations of machinery and testing apparatus, as well as a series of pictures showing the trend of women's fashions during the period under review.

DIE RAMIEKULTUR. By Prof. Dr. Kempski. Pp. iv + 116, 8¼ × 5. (Hamburg: Tropenverlag Fr. W. Thaden, 1931.) Price 5 M.

The question of the possibilities of ramie cultivation as an industrial enterprise has been frequently discussed, but hitherto it does not seem to have been found feasible to produce the fibre profitably on a commercial scale in competition with the crop grown in China and exported under the name of " China grass."

The author of the present work, however, expresses the view that even under existing conditions, when cotton production exceeds the consumption, ramie cultivation may well be recommended for the following reasons. Ramie possesses such great advantages over cotton for certain purposes that it will find a market provided that it can be offered regularly in sufficient quantities and at a reasonable price. Numerous flax mills would turn their attention to ramie or admixtures of ramie with flax which to-day find flax spinning too risky an undertaking owing to the uncertainty of the supply of flax and the fact that its price is often too high. As the ramie plant requires a different soil and a different climate from those demanded by cotton, and since its fibre not only possesses great advantages over cotton but also lacks certain properties possessed by the latter, the two fibres may be regarded as complementary to each other from both agricultural and textile standpoints. There will always be a need for both fibres.

While giving due weight to Dr. Kempski's opinions expressed above, one can scarcely agree that the production of ramie on a commercial scale could be safely recommended at the present time, as such an enterprise would be highly speculative unless there was an assured market for the crop.

The book deals with the characters of the ramie plant and its fibre, discusses the questions of soil, climate and cultivation, and describes the machines which have been devised for the preparation of the fibre. It is provided with numerous illustrations and a useful bibliography.

The Digestion of Grasses and Bamboo for Paper-making. By W. Raitt, M.I.Chem.E., F.C.S., Cellulose Expert to the Government of India (Ret.), with Microphotographs by L. N. Seaman, B.Sc., Wood Technologist at the Forest Research Institute, India, and a Foreword by R. H. Clapperton. Pp. xi + 116, with 20 plates, 10 × 7½. (London: Crosby, Lockwood & Son, 1931.) Price 21*s.*

The author of this work has been engaged for twenty-five years in a study of the digestion of grasses for the production of paper-pulp. After a brief introduction, in which reference is made to the comparatively meagre attention previously devoted to the subject and to the lack of knowledge of the chemical changes taking place during the process of digestion, a short account is given of the history of pulping. Attention is then drawn to the limitations affecting the choice of a product for paper-making, and the possibilities of various graminaceous plants, including the cereal straws, savannah grasses and bamboos.

In a chapter entitled "Analysis," the chemical composition of grasses is considered, and the various constituents are classed in four groups as follows: Group I, consisting of starch, sugar and other substances soluble in water at 100° C.; Group II, pectins and other substances soluble in sodium hydroxide solution (1 per cent.) at 100° C.; Group III, lignins and other compounds soluble in sodium hydroxide solution (4 per cent.) at temperatures above 150° C.; Group IV, cellulose, the insoluble residue from the foregoing. On the basis of this classification of the chemical constituents of the grasses, the author has devised a process of "fractional digestion" which is discussed in chapters dealing with digestion systems and digestion problems generally.

Other chapters deal with (1) plant nutrition and the building up of the ligno-cellulose complex; (2) bamboo, its occurrence and growth; (3) bamboo, its chemical constitution and physical characteristics; (4) manufacturing facilities and transport, indicating the local conditions necessary for the establishment of a profitable pulping industry; and (5) the microscopical features of bamboo.

The book, with its illustrations, is printed on pure bamboo paper, manufactured from pulp produced at the Forest Research Institute, Dehra Dun, India. A specimen of the pulp in the unbleached condition is inserted at the end of the book. The work will be invaluable to all persons actually engaged in the production of paper-pulp from bamboos or grasses as well as to those contemplating the development of a project of this nature.

AN ECONOMIC VIEW OF RUBBER PLANTING. By Soliva. Pp. 137, 9 × 6. (Singapore: Kelly & Walsh, Ltd.; London: Kelly & Walsh (London) Ltd., 1931.)

As the author explains in his preface, he is not a planter but a banker, and having travelled a great deal in the East he has collected information on the economic and financial aspects of rubber planting in Malaya, Ceylon and the Dutch East Indies. General summaries are given of the conditions of the industry in these regions, but most attention is devoted to the matter of "the cost of bringing one acre into bearing, and the cost of producing one pound of rubber."

For each of the geographical sections a sketch of the local history of rubber and of the development of European plantations precedes a discussion of natural conditions, soil, climate, topography, etc. Cultivation methods, yields per acre, labour wages and health conditions are dealt with, leading up to a summary of the costs per acre and per pound, and a consideration of the general financial aspects of the industry. The author points out discrepancies due to different methods of accounting; for example British companies commonly give f.o.b. costs, whilst Dutch companies include home expenses, allowances for depreciation, etc. He then gives details of methods of calculating costs, based on (*a*) f.o.b. cost, and (*b*) all-in cost.

The volume should be of value to all interested, whether as directors, managers or shareholders, in the great rubber industry of the East.

FOREST MEASUREMENT. By Harold C. Belyea, Assistant Professor of Forest Engineering, New York State College of Forestry. Pp. xviii + 319, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1931.) Price 17*s.* 6*d.*

Forest mensuration is defined by the Society of American Foresters as the science which deals with the determination of the volume of stands, trees and logs, and with the study of the growth and yield of trees and stands.

This book treats of the different kinds of measurement and computation employed in such determinations, the instruments used for the various purposes, and the methods of calculating results and appraising their significance. Consideration is given to the various mathematical devices (graphs, alignment charts, anamorphic curves, etc.) used in dealing with the facts and figures of mensuration, and to their possibilities and limitations; and a chapter is devoted to statistical methods in their application to forest measurement.

The volume is intended for students approaching forest mensuration for the first time, and will serve as a useful introduction to the subject.

THE CORROSION OF THE TIN-PLATE CONTAINER BY FOOD PRODUCTS. By T. N. Morris, M.A., Dip. Ag., and J. M. Bryan, B.Sc. Department of Scientific and Industrial Research, Food Investigation, Special Report No. 40. Pp. viii + 85, 9½ × 6. (London: His Majesty's Stationery Office, 1931.) Price 1*s.* 6*d.*

This report contains the results of three years' work on what "is generally regarded as the most fundamental problem with which the canning industry is confronted, namely, the corrosion of the tin-plate container."

An interesting summary is given of previous research on corrosion and also of the methods and objectives of the work at the Cambridge New Temperature Research Station.

The investigations reported on in this publication are preliminary work on the corrosion of iron and steel; the influence of the hydrogen-tin concentration on the corrosion of steel, tin, the tin-iron couple and tin plate; the inhibitors and accelerators of corrosion; the corrosion and discoloration of canned goods, and practical experiments on various products including remedial measures for certain defects.

An appendix contains points of importance in the examination of canned goods for factory control. There is also a good bibliography.

MECHANICAL TESTING. A TREATISE IN TWO VOLUMES. By R. G. Batson, M.Inst.C.E., M.I.Mech.E., and J. H. Hyde, A.M.Inst.C.E., M.I.A.E., A.M.I.Mech.E. Vol. I. Testing of Materials of Construction. Pp. xv + 465, 8½ × 5½. Second edition. (London: Chapman & Hall, Ltd., 1931.) Price 21*s.*

A notice of the first edition of this volume, issued in 1922, was published in this BULLETIN (1922, **20**, 284), and it is not necessary to comment further here on the general excellence and utility of the work. It may, however, be mentioned that in view of the progress made during the last few years in the standardisation of methods of testing and the issue of new specifications by the British Engineering Standards Association, portions of the volume have been rewritten "in order to give full weight to B.E.S.A. requirements." The authors have also enlarged the chapters dealing with fatigue testing, hardness testing, and the testing of materials at high temperatures.

PRACTICAL ORTHOGRAPHY OF AFRICAN LANGUAGES. International Institute of African Languages and Cultures. Memorandum I. Revised edition. Pp. 24, 9½ × 6½. (London: Humphrey Milford, Oxford University Press, 1930.) Price 1*s.*

This is the second edition of a pamphlet compiled to assist the solution of the problem of finding a practical and uniform method of writing African languages. It is stated that within two years 3,000 copies in English and 500 in German of the earlier edition have been sold, and that the present issue is being printed in English, French and German. The compilers point out that their memorandum is "not a document providing ready-made alphabets for every African language" and that "there still remain many African sounds for which we are not yet in a position to make recommendations." Nevertheless the pamphlet is a valuable contribution to the study of a complicated as well as interesting and important subject.

WORLD MINERALS AND WORLD POLITICS. By C. K. Leith. Pp. xii + 213, 7½ × 5. (London: McGraw-Hill Publishing Co., Ltd., 1931.) Price 10s.

A number of publications on the distribution and control of the World's minerals have appeared since the War, most of them in the United States, and the author of the book under review has had much to do with several of them, so that he is very familiar with his thesis.

The subject-matter of the introductory chapter, which is amplified in the subsequent seven chapters, may be looked upon as a summary of the dominant ideas of the book and includes the following: the great growth in the consumption of metals since the industrial revolution, especially extraordinary since the beginning of the present century; the confining of the metalliferous industries of the world to the countries bordering the North Atlantic Ocean, notwithstanding the fact that many ores are brought from distant countries; the consequent interdependence of the manufacturing nations as regards mineral supplies; the world movement of minerals, which raises the question of the freedom of the seas in time of war; the monopoly of control of some minerals by single or by co-operating groups of companies; cartels and vertical trusts and the necessity for foreign capital for exploitation, due to the inevitable consequence of irregular distribution of mineral reserves among the nations.

The subsequent chapters deal more specifically with the rise and fall of metal production in different countries and their causes; the mineral positions of the important nations; what they are doing politically in a number of detailed directions with descriptions of the methods employed severally by a number of them; the nature of specific political measures, such as tariffs, bounties, taxes, concessions, etc.; the methods of conservation of resources; minerals when accumulated, as a means of prosecuting war, and as deterrents, when supplies are controlled or limited.

The last chapter, dealing with the salient trends of the mineral industry, shows that the present large demand for minerals can be satisfied only by the concentration of production from a comparatively few large reserves found unequally among the nations.

The book can be strongly recommended for a study of the world's mineral position. It is well printed and indexed.

MINERALS IN MODERN INDUSTRY. By Walter H. Voskuil, Ph.D. Pp. ix + 350, 9 × 5¾. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1930.) Price 18*s.* 6*d.*

Dr. Voskuil's latest work is on minerals regarded from an industrial point of view. The chapters on coal, petroleum and natural gas are very informative, especially the portion relating to the over-production of oil and conservational tendencies. " Unit operation " as carried out in the Masjed-i-Suleimar field in Persia is described, and the objections raised to the application of that operation to the oil pools of the United States are given, and the methods by which those objections can be overcome are pointed out. In the United States there was in 1930 a substantial decrease in crude oil production, brought about by price cuts and the regulation of legislation in California (gas conservation law).

In the chapter on iron, the transportation of lake ores is well described. Samples of ten carloads are analysed, and the results entered in a " train sheet." In the dock, " ore blocks " containing tonnages of ore of specific analyses are laid out. Besides being segregated into Bessemer and Non-Bessemer, the ores are divided according to the percentages of iron, silica and manganese. Hence, if a certain grade of ore is desired for shipment, two or more blocks of different analyses may be mixed to bring the ore up or down to the required level.

One chapter is devoted to the alloying metals of steel, viz. manganese, chromium, nickel, tungsten, molybdenum and vanadium. The next four chapters are on copper, bauxite and aluminium, lead and zinc, and the minor industrial minerals as tin, fluorspar, asbestos, magnesite, platinum, antimony, mica, mercury and gypsum. Other chapters are on mineral fertilisers, phosphates, potash, sulphur and cement. The final chapter is on some problems of the mineral industry, including international control of minerals.

The work is well written throughout. The information given is up to date, and from an industrial point of view, is of considerable value, as it supplies a long-felt want.

GENERAL STRATIGRAPHY. By J. W. Gregory, LL.D., D.Sc., F.R.S., and B. H. Barrett, M.A., B.Sc. Pp. xii + 285, 7½ × 5. (London: Methuen & Co., Ltd., 1931.) Price 10*s.*

This book summarises briefly the main outlines of the world's stratigraphy, and in so far as this can be satisfactorily accomplished in 236 pages, the work is particularly interesting, and should prove of considerable value to students, who usually find this subject of more than ordinary difficulty.

The work is divided into five sections dealing respectively with a general introduction to the principles of stratigraphy (21 pp.), the Pre-Cambrian or "Pampalozoic" Era (45 pp.), the Palæozoic Era (92 pp.), the Mesozoic Era (47 pp.), and finally the Kainozoic and Quarternary Eras (53 pp.). There are also three indexes of geographical names, authors and subjects; a tabulated appendix of stratigraphical formations (18 pp.); ten maps, nine of which aim at showing the world distribution of land and water at successive stages of geographical evolution; and thirty-six sketches of fossils and geological sections.

Such a large task as the authors have carried out, with a marked measure of success, is almost inevitably a work of omission and compression; but making due allowance for this the book should be found very useful as a general account of comparative stratigraphy.

ELEMENTS OF ENGINEERING GEOLOGY. By H. Ries, Ph.D., and Thomas L. Watson, Ph.D. Pp. vii + 411, 9 × 5¾. Second edition. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1930.) Price 18*s.* 6*d.*

The first edition of this well-known textbook on engineering geology appeared in 1921, and was duly noted in this BULLETIN for that year (1921, **19**, 436). The present edition is essentially a reprint of the first, with, however, the valuable addition of two new chapters dealing respectively with the geology of reservoirs and dam sites (20 pp.), and general stratigraphical geology of the North American Continent (48 pp.).

The work is well written and profusely illustrated, and should prove of considerable value to engineers, whether engaged in highway constructions, tunnelling, quarrying, river and harbour improvement, water supply, mining, etc., in which connections they are almost certain to encounter problems of a geological character.

The publishers are to be congratulated on reducing the original price from 22*s.* to 18*s.* 6*d.*

THE CHEMICAL ANALYSIS OF ROCKS. By Henry S. Washington, Ph.D. Pp. xvi + 296, 9 × 6. Fourth Edition, Rewritten and Enlarged. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1930.) Price 20*s.*

The third edition of Washington's manual on the chemical analysis of rocks was published in 1919 and the present fourth edition has been thoroughly revised and partly rewritten.

Descriptions have been added of several fresh methods involving the employment of organic reagents, which are finding an increasing use in silicate analysis. The author in fact remarks in his preface that " it would seem that the rock-analyst of the future will carry out many, if not most, gravimetric separations and determinations by the use of specific reagents (mostly organic, such as cupferron and dimethylglyoxime), together with special volumetric or colorimetric methods for certain constituents, as we now do for iron and titanium." For example, in this edition details are added of the gravimetric determination of titanium by means of cupferron and also of the use of hydroxyquinoline for the estimation of magnesia, whilst in a new section on beryllia the use of hydroxyquinoline is advocated as the best method for the separation of beryllium from aluminium, iron and titanium.

The general arrangement of the book is the same as before. It is divided into five parts dealing respectively with : (1) Introductory remarks on the general character of an analysis, the constituents to be determined, microscopic examination, etc. ; (2) Apparatus and Reagents ; (3) Sampling ; (4) Operations ; (5) Methods ; and even greater attention is given to detailed description of manipulation than in the former edition.

Some minor changes in the methods of analytical procedure advised may be noted, such as the co-precipitation of manganese, in exact work, with aluminium and iron by the use of bromine as an oxidising agent in preference to the employment of ammonium persulphate. Potassium periodate is recommended in place of ammonium persulphate for oxidising manganese in a colorimetric estimation and details of the method previously described for the reduction and titration of iron are slightly modified.

As regards apparatus, the use of a " palau " crucible for sodium carbonate fusions is stated to have been found very satisfactory by the author, and he recommends the employment of fused silica, or vitreosil crucibles for pyrosulphate fusions to avoid wear of platinum crucibles and contamination of the estimation by platinum, also as a saving of time, since the melt separates much more readily from the crucible on cooling.

The number of references to recent literature has been increased in this edition and brought up to date, though the author states that they are not to be regarded as in any way complete.

This book has proved itself to be an indispensable aid to the beginner in the analysis of rocks, and the new edition will be welcomed by many who are engaged in this branch of analytical chemistry.

PHOSPHATES AND SUPERPHOSPHATES. By A. N. Gray. Pp. 275, 7¼ × 5. (London: International Superphosphate Manufacturers' Association, 1930.) Price 8*s.*

This handy little volume has been prepared primarily for the use of those engaged in the phosphatic fertiliser industry. It is the work of a well-known authority on all matters connected with the industry, who is the secretary both of the Fertiliser Manufacturers' Association and of the International Superphosphate Manufacturers' Association.

The object of the book is to provide a brief but comprehensive statistical history of the phosphate and superphosphate industry, to emphasise the importance of these products at the present time, and to provide those interested with as complete statistical information regarding production and consumption as can be compiled.

It commences with an account of the various uses of phosphates and goes on to deal briefly with the producing countries in chronological order of their entry into production, showing how slow was the development of the industry at first and how very rapidly it has grown in modern times. Then follows an account of the various grades of phosphate produced in the different countries with detailed chemical analyses, and chapters on phosphate consumption and trade which are of an eminently practical character. Superphosphate is then dealt with, the production, consumption and trade being examined in the light of the statistical information available. All this, which occupies only 84 pages, is written in a clear and concise manner, and provides a complete statement of the present world phosphate situation, and the manner in which it has arisen.

The rest of the book is occupied by detailed statistical tables concerning the production and trade in phosphate and superphosphate, and includes information of a character which could not be gleaned entirely from official publications. The book provides the most complete and up-to-date statement of the facts that could well be wished for.

THE JAPANESE EARTHQUAKE OF 1923. By Charles Davison, Sc.D., F.G.S. Pp. xii + 127, 8½ × 5½. (London: Thomas Murby & Co., 1931.) Price 7*s.* 6*d.*

The Japanese earthquake of 1923 was notable as compared with most earthquakes on account of the appalling loss of life and property over a large area. The author has obtained his material for this book from the voluminous and well-illustrated report of the Japanese Home Office and from over forty monographs and reports written by a number of Japanese earthquake specialists. From these sources he has put together in a book of very handy size a most comprehensive account of the disaster, and so well illustrated with photos, maps and diagrams and supplied with statistics that it can well be regarded as a very useful earthquake textbook.

The book is divided into two parts, the first in five chapters dealing with the human side of the catastrophe, including, as regards both Tokio and Yokohama especially, accounts of the loss of life and destruction of property caused both by the earthquake and the subsequent great fires, the insurance problem, relief funds and the rebuilding which was necessitated. The fortitude of the stricken people and the extraordinary efficiency of the Japanese authorities in arranging relief measures are shown to have been remarkable.

The second part of ten chapters is entirely devoted to the scientific aspect of the disaster, containing details of the previous great earthquakes of the world and the thirty-five in Japan since the year 818, isoseismal lines, epicentres and means of determining their positions, the propagation of earthquake waves, the various dislocations that happen to the earth's crust, seismic sea waves, and specially, the origin of the particular earthquake under description.

BOOKS RECEIVED FOR NOTICE

REPORT OF THE FOOD INVESTIGATION BOARD FOR THE YEAR 1930. Department of Scientific and Industrial Research. Pp. vii + 175, 9½ × 6. (London: His Majesty's Stationery Office, 1931.) Price 3*s.*

DIRECTORY OF PAPER MAKERS OF GREAT BRITAIN AND IRELAND FOR 1931. Pp. 276, 10¼ × 7¼. (London: Marchant Singer & Co., 1931.) Price 5*s.*

THE EMPIRE FORESTRY HANDBOOK, 1931. Edited by Fraser Story. Pp. 189, 8½ × 5½. (London: The Empire Forestry Association, 1931.) Price 3*s.* 6*d.*

Artificial Resins. By Johannes Scheiber, Ph.D., and Kurt Sandig, Ph.D. Translated from the German by Ernest Fyleman, B.Sc., Ph.D., F.I.C. Pp. vii + 447, 8½ × 5½. (London: Sir Isaac Pitman & Sons, Ltd., 1931.) Price 30*s.*

The Soil and the Microbe. By Selman A. Waksman and Robert L. Starkey. Pp. xi + 260, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1931.) Price 17*s.* 6*d.*

Foundations of Geology, being a combination of Outlines of Physical Geology, prepared from the third edition of Part I of a textbook of geology by the late Louis V. Pirsson and Charles Schuchert, by Chester R. Longwell, pp. x + 356 (1930), and Outlines of Historical Geology, second edition, rewritten by Charles Schuchert, pp. 328 + xlvii (Index), 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1931.) Price 25*s.*

The Geology of Malaya. By J. B. Scrivenor, M.A., F.G.S. Pp. xx + 217, 8¾ × 5¾. (London: Macmillan & Co., Ltd., 1931.) Price 16*s.*

Modern Tilemaking. By Alfred B. Searle. Pp. 430, 8½ × 5½. (London: H. Greville Montgomery, 1930.) Price 12*s.* 6*d.*

Reinforced Concrete Bridges. By W. L. Scott, M.Inst.C.E., assisted by C. W. J. Spicer. Third edition, revised and enlarged. Pp. xii + 268, 9¼ × 6. (London: Crosby, Lockwood & Son, 1931.) Price 28*s.*

Catalogue of Lewis's Medical and Scientific Circulating Library. Supplement, 1928–1930. Pp. 112, 8½ × 5½. (London: H. K. Lewis & Co., Ltd., 1931.) Price 2*s.* (1*s.* to subscribers).

The Soviet Five-Year Plan and its Effect on World Trade. By H. R. Knickerbocker. Pp. xx + 245, 7¼ × 5. (London: John Lane, The Bodley Head, Ltd., 1931.) Price 8*s.* 6*d.*

BULLETIN OF THE IMPERIAL INSTITUTE

A RECORD OF PROGRESS RELATING TO
AGRICULTURAL, MINERAL AND OTHER
INDUSTRIES, WITH SPECIAL REFERENCE TO
THE UTILISATION OF THE RAW MATERIALS
OF THE DOMINIONS, COLONIES AND INDIA

VOL. XXIX. NO. 3
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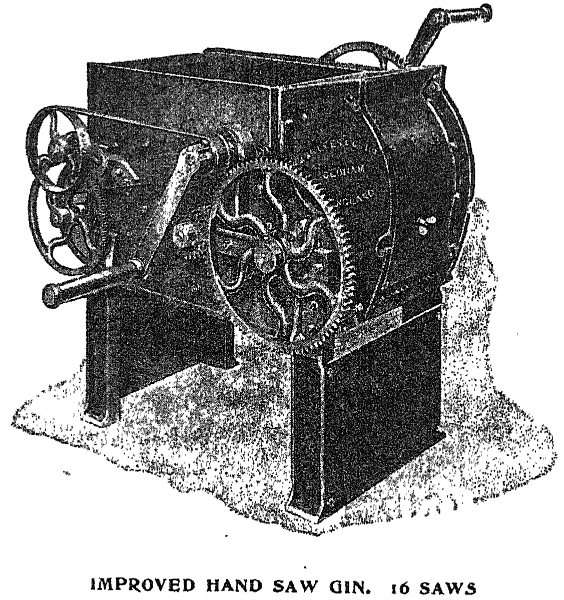

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REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

TEA FROM NYASALAND

The three samples of tea which are the subject of this report were forwarded to the Imperial Institute by the Director of Agriculture in March 1931.

The teas, which had been manufactured locally, were forwarded for observations on their appearance, quality, liquoring properties and taste, and any faults in withering, fermenting or firing that might be apparent. It was also desired to learn their commercial value and their suitability for the United Kingdom market.

Two of the samples were stated to represent respectively Manipuri leaf and a local jat, whilst the third was composed of equal quantities of the same two jats mixed before withering, and was submitted in order to ascertain the advisability of mixing leaf of different jats from the point of view of withering and fermenting.

It was mentioned that the teas were manufactured in February, a time of year not considered suitable for obtaining a product of high quality.

Description

The samples (A, B and C) weighed about 3 lb. each, and all consisted of fairly black tea in the form of rather small broken pieces. They were described as follows:

" *A. Indian B.O.P.* Leaf taken entirely from bushes grown from Manipuri seed imported from Assam, planted out February–March 1925 as 11-month seedlings. Withered for 21½ hours; loss of moisture 35 per cent."

"*B. Local B.O.P.* Leaf entirely from bushes grown from acclimatised local seed. Withered for 20½ hours; loss of moisture 38 per cent."

"*C. Indian and Local (Mixed) B.O.P.* Leaf composed of equal quantities of Manipuri and local jats mixed before spreading for withering. Withered for 21 hours; loss of moisture 38 per cent."

The teas had all been manufactured by the following process:

Rolling.

1st roll: 30 minutes without pressure.
2nd roll: same as 1st.
3rd roll: 15 minutes without pressure followed by 5 minutes' hard pressure, 5 minutes' light and 5 minutes' hard pressure.
4th roll: 15 minutes of hard and 15 minutes of light pressure in alternating periods of 5 minutes each.
5th roll: same as 4th.
Number of revolutions per minute, 54.
Temperature of rolling-room, 76° F.; humidity, 84 per cent.

Fermenting.

During 3 hours 5 minutes from start of rolling; temperature of fermenting-room, 77° F.

Firing.

In one operation in Paragon drier at 210°.

Results of Examination

The teas were examined with the following results:

		A.	B.	C.
		Indian B.O.P.	Local B.O.P.	Mixed Indian and Local B.O.P.
		Per cent.	*Per cent.*	*Per cent.*
Moisture		7·7	7·9	7·4
Expressed on the moisture-free tea	Caffeine	4·53	3·99	4·42
	Tannin	12·0	15·7	14·9
	Hot water extract [1]	51·9	50·8	49·0
	Total mineral matter	5·31	5·39	5·15
	Ash, soluble in water	3·57	3·81	3·56
	,, insoluble in water (less silica)	1·54	1·32	1·56
	Silica	0·20	0·26	0·03

[1] *By Tatlock and Thompson's method.*

The foregoing results show that the samples are very similar to one another in composition, and that the analytical figures are, on the whole, normal for Indian teas.

Commercial Valuation

The teas were submitted to brokers and importers in London. The brokers furnished the following observations.

A. Blackish, fairly even Broken Orange Pekoe ; a fair amount of tip. Liquor has fair colour and strength ; fairly useful. Infused leaf a little mixed ; some leaves are of a good colour. Value, 9½*d*. to 10*d*. per lb.

B. Rather more leafy than the above, with distinctly more tip. Liquor has better colour and strength, with preferable quality to the above. Infused leaf, distinctly brighter than the above. Value, 1*s*. 2*d*. per lb.

C. Same size as A, with distinctly less tip. Liquor has fair strength and colour ; fairly useful. Infused leaf ; only a few leaves have fair colour. Value, 8*d*. to 9*d*. per lb.

We would describe the teas represented by the three samples as Broken Orange Pekoes, and all would be suitable for our market. We have recently sold teas from Nyasaland similar to the above and the valuations have been based on these sales.

The tea represented by Sample B is best both as regards style of leaf and character of liquor, and we would not advise this being mixed with any other jat.

As regards Sample C, this is inferior to A and B both in liquor and leaf. We are of opinion that it is not advisable to mix the leaf of different jats from the point of view of withering and fermenting, although, of course, if it was only a small acreage the different jats would have to be put together.

The importers submitted the teas to their technical advisor, whose observations they transmitted as follows :

From the appearance of the dried leaf, there is no doubt that Sample B shows a greater amount of tip and a better length of leaf. Sample A comes second, and C third.

Regarding liquors, there is little to choose between A and B, but C, although duller, is thicker than the other two.

With regard to the general leaf appearance, there does not appear to be very much wrong with the manufacture, although the sifting could be considerably improved upon. The liquors point to very faulty manufacture, the infused leaf being altogether too dark. Nothing absolutely wrong with the firing can be detected, and the withering also appears to have been correct, at any rate as regards the physical wither. The character of the liquors in general, however leads to a suspicion that chemical wither has not taken place.

The Advisor notes that Sample B is a tea produced from a "local jat," and states that he would be able to give more decided opinions on the jats if he were told what was the origin of this sample. Judging from appearance alone he would say it was from a dark Assam and not from a Manipuri; this would account for the greater amount of tip shown in the sample.

It would not be advantageous to mix a thin leaf tea, such as that derived from a dark or light leaf Assam, with a thick leaf such as Manipuri. Wither would certainly be uneven if they were mixed together.

The value of the teas would compare with the prices at present ruling for teas obtained from a low elevation estate in Ceylon or Southern India.

From the details of manufacture given, the system carried out appears to be a fairly sound one, and the Advisor can only gather that the poor quality of the tea may be due to outside climatic conditions, the teas having been manufactured at an unsuitable time of the year; this does not seem probable, however, when one considers the withering results, e.g. the loss of moisture of 35 per cent. in 21½ hours, although a better result might have been obtained if the physical wither had shown a loss of 38 per cent. in 18 hours. Therefore, he would advise a harder wither in a shorter time.

The Advisor thinks that the rolling might be improved upon, and suggests the following:

1st roll: 30 minutes without pressure.
2nd roll: 30 minutes with light pressure.
3rd roll: 30 minutes, with medium hard pressure, 5 minutes off and 5 minutes on.

4th roll: same process.
5th roll: First, 10 minutes without pressure. Second, 10 minutes with hard pressure. Final, 10 minutes without pressure.

Regarding fermentation, he suggests fermenting the fine bulk for 3½ hours from the commencement of rolling, and the coarse bulk for 4½ hours from the commencement of rolling. He would be interested to see samples of tea manufactured by this process.

As regards the actual suitability for the London market of the teas represented by the present samples, the importers considered that Sample B would be attractive to the trade whilst A would be regarded as moderately useful.

Remarks

The results of the present investigation show that these samples of tea are of promising quality. Although such teas would be readily saleable, it might be advisable to carry out further trials by the modified methods suggested by the Technical Advisor of the firm of importers, and it was suggested to the Nyasaland authorities that if this were done the Imperial Institute would be glad to receive further samples for submission to the firm. It would appear undesirable to proceed further in the preparation of the mixed tea represented by Sample C.

SOILS FROM HONG KONG

The sixteen samples of soil which are the subject of this report were sent to the Imperial Institute by His Excellency the Governor, Hong Kong, for analysis, in order that suggestions might be made regarding suitable crops for cultivation on the soils. As there is little published information available regarding the soils of Hong Kong, a fairly comprehensive analysis was made.

The samples represented eight soils and eight sub-soils, the majority being from uncultivated land. The descriptions of the soils, with information regarding the localities from which they were obtained, typical vegetation and type of soil were as follows :

A. Top- and sub-soil; from So Kwun Wat; cultivated ; first-class padi crops recently grown ; a greyish sandy loam.

B. Top- and sub-soil; from Chuk Shan Lung, Ma Wat Wai, Fanling; uncultivated ; pine and wild trees, bamboo, ferns and grass growing ; a yellowish loam.

C. Top- and sub-soil; from Chun Lung; uncultivated ; pine and wild trees, ferns and grass growing ; a yellow clay loam.

D. Top- and sub-soil; from Chung Uk Chun, Tin Shum, Castle Peak; uncultivated ; large wild trees, bamboo, ferns and grass growing ; a grey sandy loam.

E. Top- and sub-soil; from Kuei Island; cultivated ; green vegetables in good condition growing ; a greyish sandy loam.

F. Top- and sub-soil; from Tai Long Wan, Lo Kong, Shek O; cultivated ; fair crop of padi growing ; a pinkish brown loam.

G. Top- and sub-soil; from Shek Kwu Lung; uncultivated ; pine and wild trees, ferns and grass growing ; yellowish brown loam.

H. Top- and sub-soil; from Tai Pak, Lantao; uncultivated ; pine and wild trees, ferns and grass growing ; a yellowish grey sandy loam.

The samples were submitted to chemical and mechanical analysis at the Imperial Institute with the results shown in the tables on pages 277–281.

Remarks and Recommendations

Sample A.—This soil is a sandy loam, grey in colour, the sub-soil being lighter in texture and more sandy than the top-soil. The amount of moisture retained by the air-dry soil is rather low. Soluble salts do not occur in sufficient quantity to be injurious to crop growth, but the reaction of the soil is strongly acid.

The amounts of the essential plant food constituents are rather low, but will probably prove sufficient for

RESULTS OF EXAMINATION

PRELIMINARY MECHANICAL ANALYSIS ON THE ENTIRE SOIL WHICH WAS AIR-DRIED BEFORE EXAMINATION

(Results in percentages)

Size of particles in mm.	A		B		C		D		E		F		G		H	
	Top.	Sub.	Top.	Sub.	Top.	Sub.	Top.	Sub.	Top.	Sub.	Top.	Sub.	Top.	Sub.	Top.	Sub.
Stones and gravel over 2·0	8·25	10·43	14·05	25·03	0·29	1·17	5·84	9·92	12·27	5·02	18·88	6·87	7·80	5·92	10·08	11·25
"Fine earth" 2·0 and under	91·75	89·57	85·95	74·97	99·71	98·83	94·16	90·08	87·73	94·98	81·12	93·13	92·20	94·08	89·92	88·75

MECHANICAL ANALYSIS OF "FINE EARTH"

(Results in percentages)

Size of particles in mm.	A		B		C		D		E		F		G		H	
	Top.	Sub.	Top.	Sub.	Top.	Sub.	Top.	Sub.	Top.	Sub.	Top.	Sub.	Top.	Sub.	Top.	Sub.
Coarse sand[1] . 2·0 to 0·2	44·07	53·44	24·24	22·69	18·26	14·99	43·64	37·25	25·09	15·45	21·70	17·50	21·93	18·75	46·85	41·74
Fine sand[1] . 0·2 to 0·02	26·05	26·35	17·66	16·04	11·12	9·78	32·27	29·45	21·85	20·71	21·44	24·67	25·57	25·38	18·96	17·51
Silt[1] . 0·02 to 0·002	12·70	10·08	28·35	30·05	19·35	18·25	10·65	13·42	30·97	28·42	33·10	31·80	32·55	30·07	9·80	10·45
Clay[1] . 0·002 and under	14·18	10·35	26·15	28·48	43·90	49·70	10·58	17·98	18·13	29·08	19·55	22·35	14·08	21·48	19·23	23·48
Moisture at 105° C. . .	1·16	0·53	1·67	1·23	7·15	7·33	1·49	1·63	3·80	4·68	3·50	4·60	3·52	3·44	4·98	6·24
Matter soluble in water[2] .	0·026	0·024	0·028	0·018	0·016	0·014	0·042	0·040	0·058	0·059	0·044	0·033	0·023	0·011	0·022	0·015
Loss by solution in HCl .	0·25	0·15	0·59	0·29	0·55	0·31	0·53	0·38	0·62	0·18	0·33	0·19	0·64	0·35	0·32	0·27
Calcium carbonate . .	nil	nil	nil	nil	nil	nil	nil	nil	0·11	nil	nil	nil	nil	nil	nil	nil
Loss on ignition (not including moisture at 105° C. or CO_2 from carbonates) . .	3·68	2·14	6·15	5·15	9·78	8·81	3·26	2·98	5·15	7·25	4·20	4·30	9·09	7·24	3·51	3·81
[1] Fractions dried at 105° C.																
[2] Containing sulphates equivalent to sulphuric anhydride SO_3	0·017	0·009	0·011	0·005	0·007	0·004	0·010	0·008	0·020	0·023	0·007	0·008	0·012	0·009	0·008	0·007
[2] Containing chlorides equivalent to chlorine Cl . .	0·003	0·005	0·004	0·004	0·005	0·004	0·006	0·003	0·015	0·020	0·010	0·011	0·003	0·002	0·003	0·003
Reaction of soil . . .	Strongly acid.	Acid.	Very strongly acid.	Very strongly acid.	Strongly acid.	Strongly acid.	Strongly acid.	Acid.	Faintly alkaline.	Faintly acid.	Acid.	Acid.	Very strongly acid.	Acid.	Very strongly acid.	Strongly acid.
*p*H value (quinhydrone method)	4·73	5·42	4·32	4·43	4·67	4·89	4·97	5·97	7·57	6·37	5·19	5·94	4·46	5·06	4·45	4·64

CHEMICAL ANALYSIS OF "FINE EARTH" PASSING A 1-MM. SIEVE (TOP-SOILS)

SOLUBLE IN HYDROCHLORIC ACID

—	A	B	C	D	E	F	G	H
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Lime . . . . CaO	0·08	0·06	0·01	0·14	0·34	0·04	0·10	0·07
Magnesia . . . . . . MgO	0·02	0·09	0·04	0·04	0·10	0·14	0·36	0·04
Potash . . . . K_2O	0·04	0·18	0·06	0·09	0·10	0·13	0·20	0·09
Soda . . . . Na_2O	0·03	0·06	0·27	0·11	0·14	0·06	0·16	0·13
Ferric oxide . . . . . . Fe_2O_3	0·79	4·48	5·30	0·73	2·68	4·03	5·75	1·19
Alumina . . . . . . Al_2O_3	4·37	5·25	9·53	3·11	6·94	7·75	11·58	7·32
Phosphoric acid . . . . . P_2O_5	0·01	0·11	0·01	0·12	0·27	0·04	0·03	trace

EXCHANGEABLE BASES (HISSINK METHOD)

—	A	B	C	D	E	F	G	H
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Lime . . . . CaO	0·046	0·011	0·008	0·132	0·276	0·034	0·012	0·018
Magnesia . . . . . . MgO	0·009	0·008	0·010	0·016	0·069	0·029	0·019	0·014
Potash . . . . K_2O	0·010	0·011	0·006	0·011	0·028	0·008	0·007	0·010
Soda . . . . Na_2O	0·008	0·005	0·013	0·006	0·014	0·022	0·009	0·014
Ferric oxide . . . . . . Fe_2O_3	} 0·009	0·031	0·011	} 0·009	} 0·003	} 0·001	trace	trace
Alumina . . . . . . Al_2O_3		0·016	0·035				0·032	0·028

CHEMICAL ANALYSIS OF "FINE EARTH" PASSING A 1-MM. SIEVE (TOP-SOILS)

AVAILABLE CONSTITUENTS, I.E. PORTION SOLUBLE IN 1 PER CENT. CITRIC ACID SOLUTION

—		A	B	C	D	E	F	G	H
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Lime	CaO	0·037	0·010	0·010	0·099	0·257	0·028	0·008	0·014
Magnesia	MgO	0·022	0·016	0·009	0·003	0·090	0·036	0·015	0·008
Potash	K_2O	0·006	0·006	0·003	0·008	0·023	0·008	0·008	0·005
Soda	Na_2O	0·009	0·008	0·010	0·013	0·022	0·022	0·008	0·010
Phosphoric acid	P_2O_5	0·005	0·001	faint trace	0·046	0·104	trace	slight trace	trace

—		A	B	C	D	E	F	G	H
		lb. per acre.	*lb. per acre.*	*lb. per acre.*	*lb. per acre.*	*lb. per acre.*	*lb. per acre.*	*lb. per acre.*	*lb. per acre.*
Lime	CaO	1,048	249	227	2,804	6,237	680	174	376
Magnesia	MgO	623	398	204	85	2,184	874	326	220
Potash	K_2O	170	149	68	227	558	194	174	138
Soda	Na_2O	255	199	227	368	534	534	174	276
Phosphoric acid	P_2O_5	142	25	—	1,303	2,524	—	—	—

CHEMICAL ANALYSIS OF "FINE EARTH" PASSING A 1-MM. SIEVE (TOP-SOILS)

—		A	B	C	D	E	F	G	H
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nitrogen . (total) . . .	N	0·071	0·126	0·110	0·112	0·104	0·060	0·183	0·062
Organic carbon ,, . . .	C	0·777	1·33	1·50	1·31	1·12	0·657	1·79	0·712
,, matter[1] ,, . . .	.	1·41	2·42	2·73	2·38	2·04	1·19	3·26	1·29
Carbon dioxide ,, . . .	CO_2	nil	nil	nil	nil	0·05	nil	nil	nil

—		A	B	C	D	E	F	G	H
		lb. per acre.	*lb. per acre.*	*lb. per acre.*	*lb. per acre.*	*lb. per acre.*	*lb. per acre.*	*lb. per acre.*	*lb. per acre.*
Nitrogen . (total) . . .	N	2,011	3,135	2,492	3,173	2,524	1,456	3,971	1,708
Organic carbon ,, . . .	C	22,011	33,093	33,988	37,110	27,182	15,945	38,843	19,618

[1] *Obtained by multiplying the figure for organic carbon by* $\frac{100}{55}$.

The figures for lb. per acre of the various constituents in the above tables are calculated for a depth of 9 in. of soil, the apparent specific gravity of the soil being taken into consideration.

	A	B	C	D	E	F	G	H
Atomic ratio $\left\{\frac{\text{Carbon C}}{\text{Nitrogen N}}\right\}$	12·8	12·3	15·9	13·6	12·6	12·8	11·4	13·5

COMPOSITION OF CLAY FRACTION (0·002 mm. and under, separated by sedimentation of TOP-SOILS)

—		A	B	C	D	E	F	G	H
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Silica	SiO_2	43·90	36·07	34·53	43·92	43·24	38·58	34·70	41·71
Alumina	Al_2O_3	34·41	29·60	32·88	32·11	33·07	30·09	31·60	35·18
Ferric oxide	Fe_2O_3	3·23	14·09	13·09	5·95	5·82	10·30	12·63	4·46
Titanium dioxide	TiO_2	0·25	0·65	0·90	0·64	0·24	0·40	0·87	0·22
Manganous oxide	MnO	0·01	nil	trace	0·13	0·11	trace	0·09	trace
Lime	CaO	nil	0·22	0·07	0·37	nil	0·10	0·12	0·13
Magnesia	MgO	0·39	0·97	0·36	0·44	0·31	0·49	0·59	0·58
Potash	K_2O	0·70	1·52	0·60	1·18	0·52	1·36	0·96	0·78
Soda	Na_2O	0·30	1·28	0·24	nil	0·26	0·44	0·12	0·38
Loss on ignition		17·00	15·19	17·43	14·96	16·50	17·85	17·89	16·26
Phosphoric acid	P_2O_5	0·19	0·18	0·13	0·70	0·35	0·12	0·54	0·08
Total		100·38	99·77	100·23	100·40	100·42	99·73	100·11	99·78

	A	B	C	D	E	F	G	H
Molecular ratio $\left\{\frac{\text{Silica } SiO_2}{\text{Alumina } Al_2O_3}\right\}$	2·17	2·07	1·78	2·32	2·22	2·18	1·86	2·02

satisfactory crop growth owing to the light character of the soil and its consequent ease of penetration by roots.

The soil appears to be most likely to need lime to correct the acidity, but subsequently potash and phosphoric acid may also be required. The percentage of nitrogen is rather low, but the ratio of carbon to nitrogen is about normal.

Sample B.—This soil is a yellowish loam, rather heavier in character than sample A. There is very little variation in mechanical composition between the top-soil and sub-soil, and the amount of moisture retained by the air-dry soil is low. Soluble salts do not occur in amounts likely to prove injurious to crops. The reaction of the soil is very strongly acid.

The amounts of the essential mineral plant food ingredients are low, especially in the case of lime and phosphoric acid. The nitrogen may be sufficient, and the ratio of carbon to nitrogen is normal.

The chief requirements of this soil would appear to be the addition of lime to correct the high acidity, whilst the addition of phosphoric acid and potash also may be necessary later.

Sample C.—This soil is a clay loam, the colour, especially that of the sub-soil, being a deep yellow. It is the heaviest soil of the present series. The sub-soil is distinctly heavier than the top-soil, but there is probably sufficient coarse and fine sand to allow of fair drainage. The amounts of water-soluble salts are low. The reaction of the soil is strongly acid.

The amounts of the mineral plant food constituents are all very low. The percentage of nitrogen is probably sufficient, but the ratio of carbon to nitrogen is decidedly higher than usual. There is an unusually high percentage of acid-soluble alumina. The ratio of silica to alumina in the clay fraction of the soil is below 2 ; this indicates a tendency for the soil to become lateritised, and this is usually a sign of poor fertility.

The soil needs lime both to correct the acidity and also for crop growth, as well as potash and phosphoric acid.

Sample D.—This soil is a greyish sandy loam, somewhat resembling sample A in mechanical composition, with the exception that in the present case the sub-soil is heavier than the top-soil. The amount of moisture retained by the air-dry soil is low. Soluble salts do not occur in harmful amounts. The reaction of the soil is acid, but distinctly less so than in the case of samples A, B and C.

The amounts of all the essential plant food constituents appear to be satisfactory. The chief requirement of the soil would appear to be small applications of lime to correct acidity.

Sample E.—This soil is a greyish medium sandy loam, the sub-soil being distinctly heavier than the top-soil, but the amount of water retained by the air-dry soil is fair. Soluble salts are present in larger amounts than in the case of the other samples, but they are probably insufficient to prove injurious to crop growth.

The reaction of the top-soil is faintly alkaline, while that of the sub-soil is slightly acid. As this relation differs from that occurring in any of the other samples, it appears probable that this soil has recently received applications of some form of lime.

The soil appears to be well supplied with all the necessary plant food elements and from the results of the chemical and mechanical analyses may be regarded as of good quality.

Sample F.—This sample is a medium loam of an unusual pinkish-brown colour. There is very little variation in mechanical composition between the top-soil and the sub-soil. There is a fair amount of moisture retained by the air-dry soil. The amounts of water-soluble salts are not excessive, but it is noteworthy that the percentage of chlorides slightly exceeds that of sulphates. The reaction of the soil is acid.

Of the essential plant food elements, the amount of lime is rather low, potash is present in fair supply, phosphoric acid is extremely low in amount and the percentage of nitrogen is rather poor. The ratio of carbon to nitrogen is normal. A large amount of acid-soluble alumina is present.

The chief requirement of this soil is phosphoric acid, following lime to correct the acidity and to prevent the reversion of the phosphate if the latter is applied in a soluble form such as superphosphate.

Sample G.—This soil is a yellowish-brown rather sandy loam, the sub-soil being markedly heavier than the top-soil. The amount of moisture retained by the air-dry soil is fair. Soluble salts are low in amount. The reaction, especially of the top-soil, is strongly acid.

The amounts of all the mineral plant food elements present are low, especially those of lime and phosphoric acid. There is a very large amount of acid-soluble alumina. The percentage of nitrogen is satisfactory, but the ratio of carbon to nitrogen is rather lower than usual.

The ratio of silica to alumina in the clay fraction of the soil is below 2, indicating a tendency for the soil to become lateritised and hence of poor fertility.

The chief need of this soil is the application of lime, followed by phosphoric acid. The potash requirement, although marked, is not so urgent.

Sample H.—This is a yellowish grey sandy loam, the sub-soil being very slightly heavier than the top-soil. The amount of moisture retained by the air-dry soil is fairly good. Soluble salts are low in amount. The reaction of the soil is strongly acid.

The amounts of most of the mineral plant food constituents present are low, especially phosphoric acid. Lime also is deficient in amount, whilst the potash may be just sufficient for crop growth for the present. Although the percentage of nitrogen is also rather low, the ratio of carbon to nitrogen is about normal.

The soil needs manuring with lime and phosphoric acid, whilst dressings of potash and nitrogen would probably be advantageous.

General Remarks and Recommendations

It will be observed that the mechanical analyses of these soils have been carried out on those portions of the original soils which passed through a 2-mm. sieve, in accordance with the recently instituted International Method for Mechanical Analysis. The chemical analyses, on the other hand, were performed on the portions of the samples which passed through a 1-mm. sieve.

The percentages of material in the soils passing a 1-mm. sieve expressed in terms of the "fine earth" passing a 2-mm. sieve are as follows :

Sample.	Material passing 1-mm. sieve, as percentage of that passing 2-mm. sieve.
A	90·75
B	94·29
C	97·88
D	92·95
E	93·44
F	95·57
G	95·22
H	91·15

It is probable that the material of diameter between 1 and 2 mm. (which would be very coarse sand) would be inert as regards plant nutrition, and hence the approximate chemical composition of the material passing a 2-mm. sieve may be calculated from the above figures, if it is desired to express the chemical and the mechanical analyses on the same basis. This would not affect the conclusions to be drawn from the results.

The soils, although not all of the same type, show no extreme variations in mechanical composition. They vary from clay loam to sandy loam and in no case is one or more of the separate fractions very low in amount.

With the exception of sample E, all the soils have an acid reaction and the acidity is higher in the top-soils than in the sub-soils ; this is as would be expected, especially in the case of uncultivated soils. In the case of sample E, in which the top-soil is faintly alkaline while the sub-soil is slightly acid and the land has been used for the cultivation of vegetables, it seems most probable, as already mentioned, that the soil has recently been limed.

There appears to be a certain amount of correlation between the available bases (i.e. those soluble in citric acid solution) and the exchangeable bases as determined by the Hissink method (leaching with ammonium chloride solution). As regards lime, the amounts found by these two methods are very similar, while the magnesia shows considerable variation; the amounts of potash extracted are similar, the "exchangeable" being very slightly higher on the whole, while the amounts of soda are fairly similar in most cases.

The ratio of carbon to nitrogen in the soils is usually 12 or 13, except in samples C and G, which would be regarded from other considerations as likely to be the least fertile of the series. A carbon to nitrogen ratio of about 12 appears to be normal.

The composition of the clay fractions separated from the various top-soils shows considerable variation. The clays from samples A, D and E are fairly similar, those from samples B and F are similar, and those from samples C and G are also somewhat similar. The clay from sample H does not show any close resemblance to the others. The silica to alumina ratio falls below 2 only in the clays from samples C and G, indicating a tendency in those samples to lateritisation, which is often associated with low fertility. The high percentage of alumina which is soluble in hydrochloric acid in samples C and G is noteworthy.

On the whole, samples A, D and E are somewhat similar in character and appear to be the most promising for cultivation, samples B and F are fairly good except for their low content of phosphoric acid, while samples C, G and H must be regarded as of poor quality.

All the soils except E have an acid reaction and for the satisfactory growth of most crops this condition needs correcting by the addition of lime or ground limestone. Ground-nuts and other leguminous crops in particular need an abundant supply of lime and prefer a soil having a neutral or alkaline reaction. Fruit trees also usually thrive best on a non-acid soil. The acidity of the soils combined with the high annual rainfall renders them not very promising for cultivation on a large scale. It is stated that pine trees are growing on most of the uncultivated land from which samples were taken, and it may be remarked that these trees usually thrive well on acid soils.

For most ordinary crops, the chief need of these soils, except sample E, is for heavy applications of lime, followed in most cases by a phosphatic manure. Of the uncultivated soils, sample D appears to be the most promising, while samples B, C, G and H would probably need extensive manuring to be of much use for crops.

As regards specific crops for these soils, if the recommendations made in this report with regard to liming and manuring are carried out, they should be suited for the growth of most ordinary crops. The cultivation of sugarcane cannot be recommended, as it requires very good supplies of all the important plant food constituents and hence makes heavy demands on the soil. Provided the soil is well supplied with lime, ground-nuts should give a satisfactory crop, particularly on the lighter soils, but this crop is unsuited to an acid soil.

It seems probable that some at least of the failures of fruit trees in Hong Kong which have been recorded in the past were due to the acid nature of the soils. When this is corrected, and provided that the fruit trees, especially in their early stages, are protected from high winds, the prospects of obtaining satisfactory crops would be much improved.

The soils, after suitable treatment and with the possible exceptions of those represented by samples C, G and H, which are of poor general fertility, should be suitable for the growing of vegetables such as cabbage, onion, cauliflower, lettuce, celery and tomatoes. The actual crops to be planted would of course have to be chosen with a view to their commercial value when grown, but it seems likely that there should be a good market in Hong Kong itself for local-grown market-garden produce.

It should be noted, however, that successful crop cultivation largely depends on local conditions, such as climate, altitude and aspect. There is evidently a very heavy rainfall between May and October, which may have an adverse influence on certain crops and must be taken into consideration.

ARTICLES

CLOTH MANUFACTURE FROM NIGERIAN WOOL

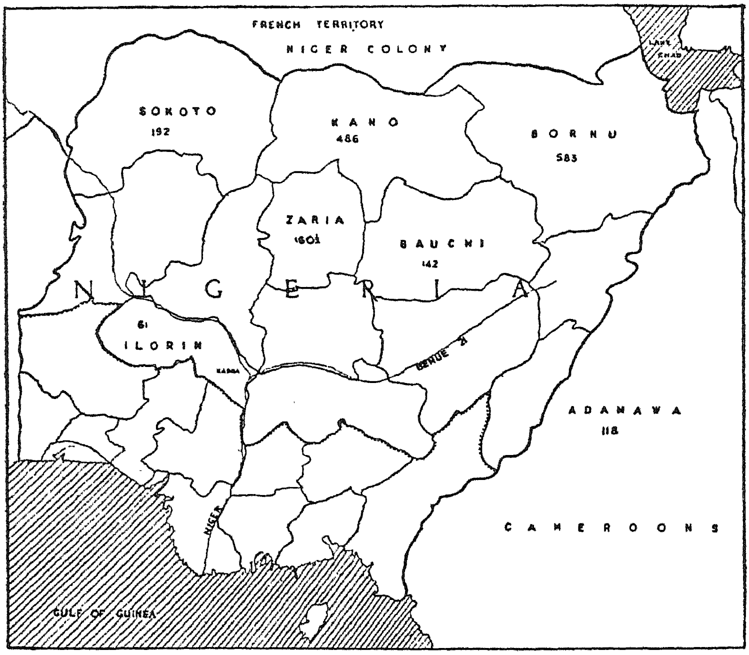
By P. Jowett and E. J. Poole

Wool Industries Research Association

Sheep breeding in Nigeria from an economic standpoint is being given serious attention by the Nigerian Government.

Although the animal is an importation from French territory and is itself not indigenous to Nigeria, the results obtained, so far as the type of wool is concerned, are indeed very promising.

SHEEP FARMING AREAS



Number of sheep for each area to the nearest thousand.

We have permission to quote the following facts recorded in the annual reports of the Veterinary Department of the Nigerian Government, which will give some idea of the work this department is doing.

We understand the largest farm centre to be at Jos, and, in 1926, sheep were imported from Daura with the object of improving the existing breed of hairy-fleeced sheep from both a mutton-producing and wool-growing point of view.

In November 1927, the yield of wool from twenty-six sheep and six lambs was 90¼ lb., whilst the fleece of a ten-month old lamb weighed 2¼ lb. and had a staple of about 8 in.

Although the quality was not deemed to be of a very high grade, there was definite evidence of improvement which indicated what could be reasonably expected from the selective breeding of these sheep.

Mr. G. C. Sambidge, Superintendent of the School of Arts and Crafts, Bauchi, scoured, teased and carded the fleece of a ewe, and then had a small length of the carded sliver hand spun.

The Department state in their 1928 report that "there is a marked improvement in the quality of the fleeces clipped in November last, and it is certain that with continued selection there is likely to be produced a wool of some economic value and local usefulness."

At this juncture we would add to their remarks and say, from our judgment and knowledge acquired by the processing of the wool, that its usefulness may become more than local, providing the handling and the transport of the wool can be put on to a commercial basis.

The map gives an idea of the distribution of the farming areas, and the 1928 return of sheep for each is given to the nearest thousand.

In Table I, sheep statistics are given for the years 1926 to 1928.

TABLE I

Province.	1926.	1927.	1928.
Adamawa . .	104,594	1,158,829	118,315
Bauchi. . .	137,076	135,305	142,196
Benue . . .	42,031	42,137	21,393
Ilorin . . .	52,739	57,546	60,964
Bornu . . .	474,032	516,926	582,822
Kabba. . .	40,044	38,795	39,155
Kano . . .	457,033	455,825	486,104
Niger . . .	32,244	36,601	39,504
Plateau . .	84,107	77,640	103,440
Sokoto. . .	273,070	252,814	191,604
Zaria . . .	112,284	98,028	160,503
Total . .	1,809,254	2,870,446	1,946,000

The Processing of the Wool

1. *Blending*

Twenty fleeces in the grease each weighing approximately three pounds were run through a small pulling machine to open and mix previous to carding; the fleeces were badly " cotted."

Remarks.—No unusual precautions were found necessary for the satisfactory pulling and mixing of the fleeces.

2. *Carding*

This operation was carried out on a two-cylinder woollen set with a one hundred end tape condenser, and the material was slubbed to 96 yards per ounce.

Remarks.—The wool presented no difficulty in carding, but it was decided not to slub any finer than six skeins owing to the great diversity in quality.

A production of 50 lb. per hour was maintained, fulfilling all practical requirements for this count and speed.

3. *Spinning*

The slubbing was spun on the woollen ring frame to ten skeins with eight turns per inch for warp, and eight skeins with five turns per inch for weft.

Remarks.—The spinning, as in the case of the carding, would only fulfil all practical requirements at this count, hence we concluded, for this material, that ten skeins was the practical spinning limit.

4. *Winding, Warping, Beaming, Looming and Sleying*

No difficulty was experienced in passing the material through each of these processes.

5. *Weaving*

The cloth was woven on a Hattersley narrow width drop box loom.

LOOM PARTICULARS

Warp	10's Yorkshire Skeins, 8 turns per inch.
Sett in reed	10/3's.
Edges	15 double each side of 20 Yorkshire Skeins, white.
Reed width	36 in. overall.
Weft	8's Yorkshire Skeins, 5 turns per inch.
Picks	24 per inch.
Weave	2/2 twill.
Grey width	34½ in. overall.
Finished width	29 in. overall.

PLATE I

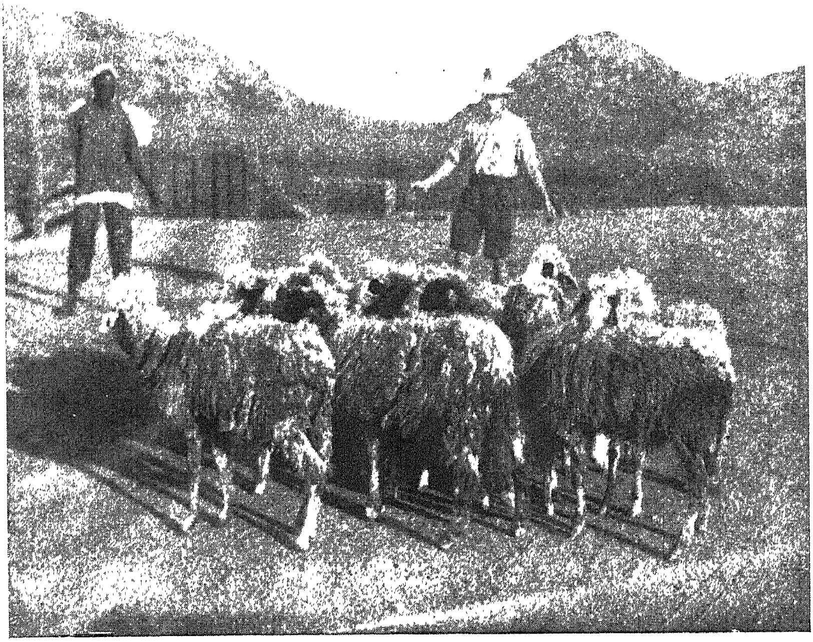


FIG. 1.—NIGERIAN SHEEP.
(*By kind permission of the Colonial Office.*)

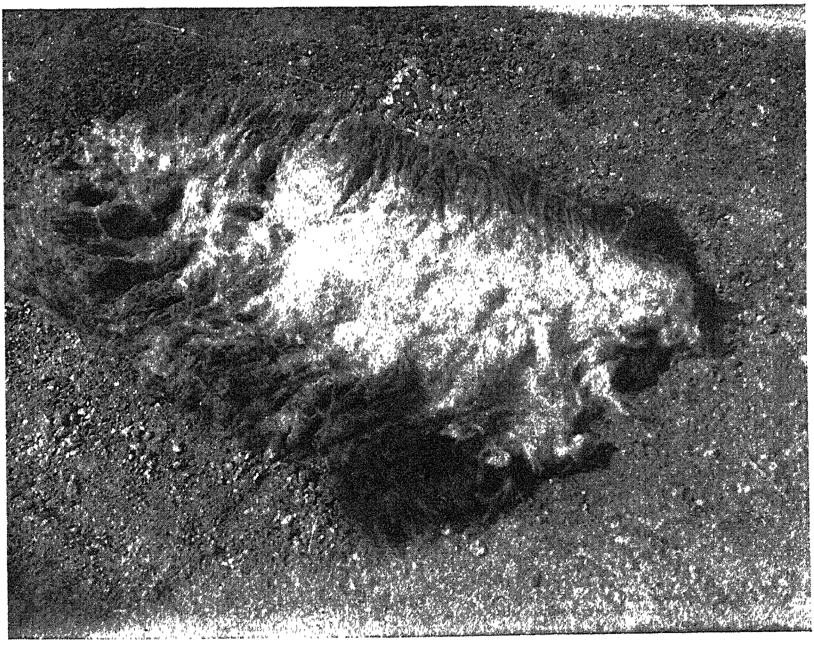


FIG. 2.—TYPICAL FLEECE OF NIGERIAN WOOL.
(*By kind permission of the Colonial Office.*)

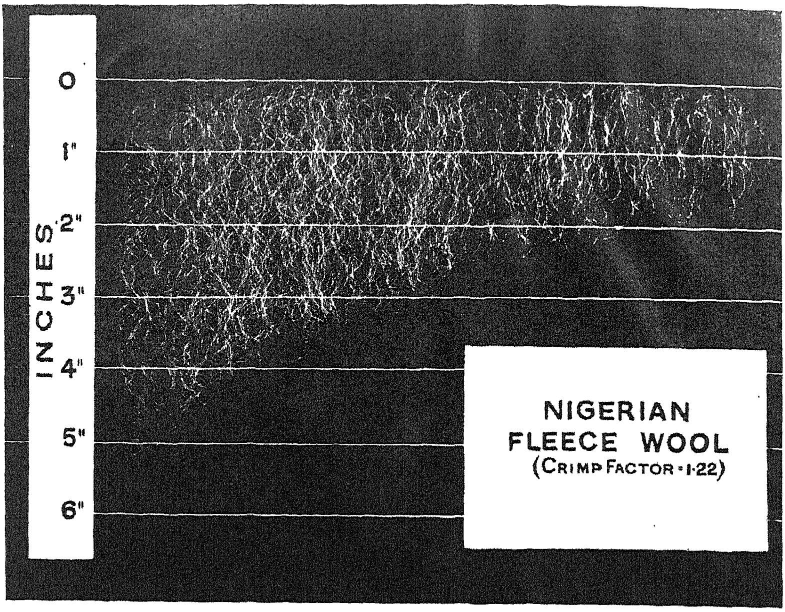
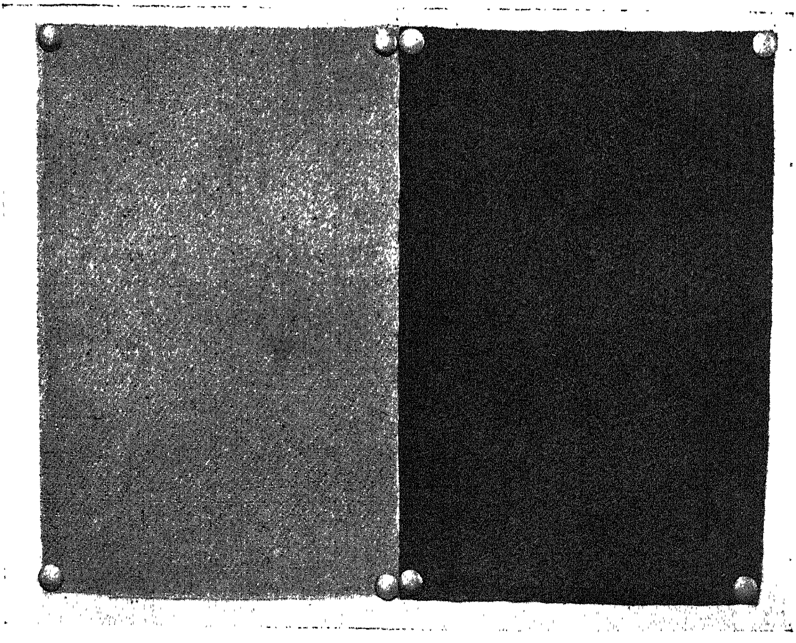


FIG. 1.



Grey. FIG. 2. Finished.

Remarks.—With the exception of ends down due to occasional soft places in the warp yarn, the yarn gave no other trouble in weaving.

The soft places in the yarn were inevitable owing to (1) quality, and (2) the required finish and handle of the cloth. They could have been hardened by extra twist, but the ultimate finish and handle would have been seriously affected.

Scouring and Milling

The cloth was milled in length about 7 per cent. and in width about 16 per cent., giving, after scouring and milling, a length of 14 yds. 24 in., and a width of 29 in. overall.

Dimensions of Test Length in the Grease

Length	15 yds. 32 in.
Width	34½ in.
Weight	14¾ lb.

Dyeing and Finishing

The length, dyed and finished, was 14¾ yds. and weighed almost 11 lb., giving a total loss from greasy to finished of practically 25 per cent.

Testing

The tests which have been applied to the material are summarised in Table II.

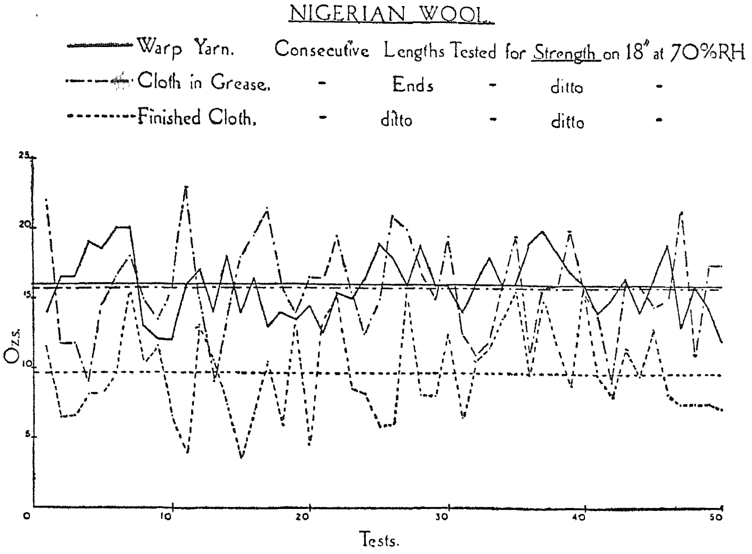
From the summary of tests some idea may be obtained regarding the influence the processes of weaving, dyeing and finishing have had on the material, the increase or decrease in yarn and cloth strength and elongation being shown in Table III.

TABLE III

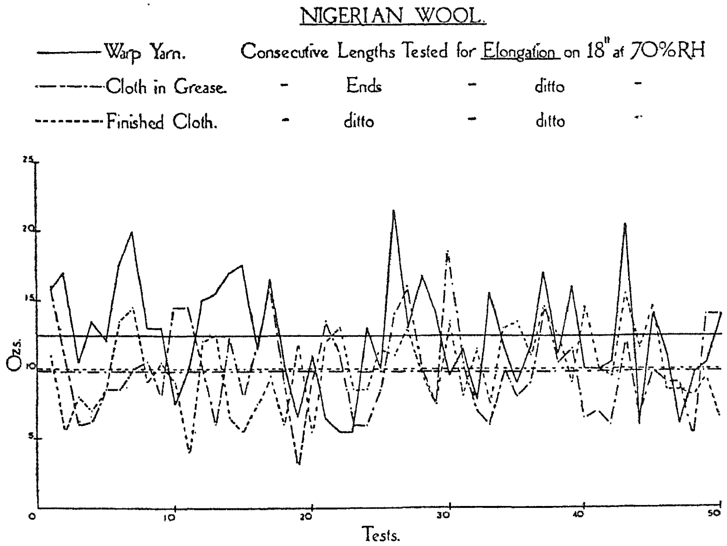
	Weaving. *Per cent.*	Dyeing and Finishing. *Per cent.*
Warp Yarn :		
(*a*) Strength	− 1·0	− 39·5
(*b*) Elongation	− 20·4	− 19·2
Weft Yarn :		
(*c*) Strength	− 9·2	− 38·7
(*d*) Elongation	− 4·1	− 10·5
Warp Way :		
(*e*) Cloth strength	—	+ 2·5
(*f*) Cloth elongation	—	+ 8·25
Weft Way :		
(*g*) Cloth strength	—	− 17
(*h*) Cloth elongation	—	+ 36·25

TABLE II

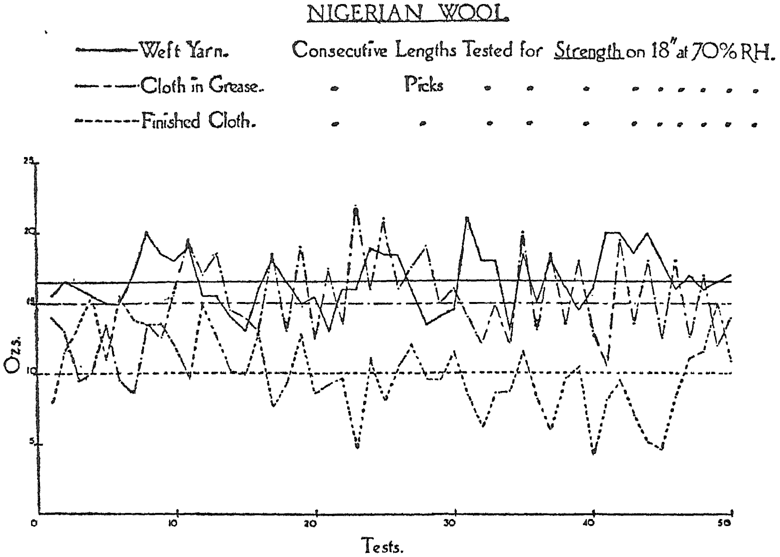
Material Tested.	Average Single Thread Strength.	See Graph No.	Average Single Thread Elongation.	See Graph No.	Coefficient of Variation.						Average Cloth Strength.		Average Cloth Elongation.		See Graph No.
					Single Thread.		$\frac{b}{a}$.	Single Thread.		$\frac{b}{a}$.	Warp Way.	Weft Way.	Warp Way.	Weft Way.	
					Strength.	R_s.		Elongation.	R_e.						
	oz.		*Per cent.*		*Per cent.*			*Per cent.*			*lb.*	*lb.*	*Per cent.*	*Per cent.*	
Warp Yarn .	15·92	1	12·43	1a	11·32	—		26·55	—		—	—	—	—	—
Weft Yarn .	16·50	2	12·17	2a	9·70	—		19·72	—		—	—	—	—	—
Ends (Greasy) .	15·75	1	9·89	1a	17·08	1·5 (a)	1·67	27·1	1·02 (a)	0·88	—	—	—	—	—
Ends (Finished) .	9·67	1	10·05	1a	28·10	2·5 (b)		24·2	0·9 (b)		—	—	—	—	—
Picks (Greasy) .	14·98	2	11·67	2a	18·0	1·85 (a)	1·25	23·55	1·2 (a)	1·04	—	—	—	—	—
Picks (Finished) .	10·12	2	10·89	2a	22·3	2·3 (b)		24·80	1·25 (b)		—	—	—	—	—
Cloth in Grease .	—	—	—	—	—	—		—	—		329	250½	31·4	22·6	4
Finished Cloth .	—	—	—	—	—	—		—	—		337½	208	34·0	30·8	4
1	2	3	4	5	6	6a	6b	7	7a	7b	8	9	10	11	12



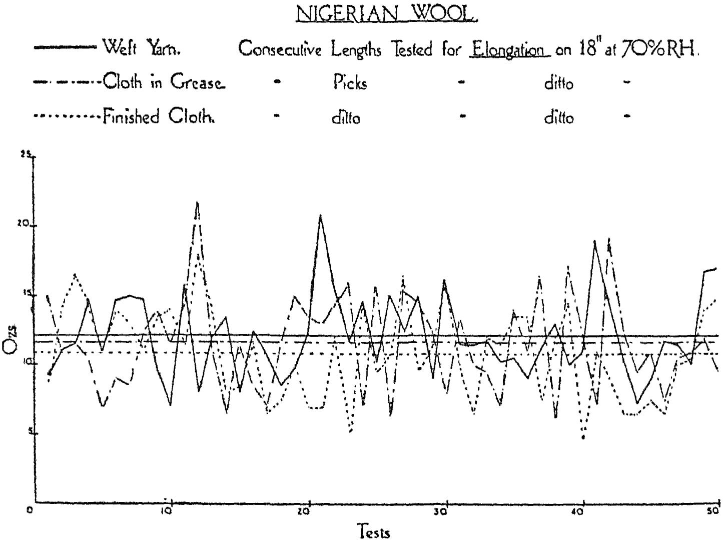
GRAPH I.



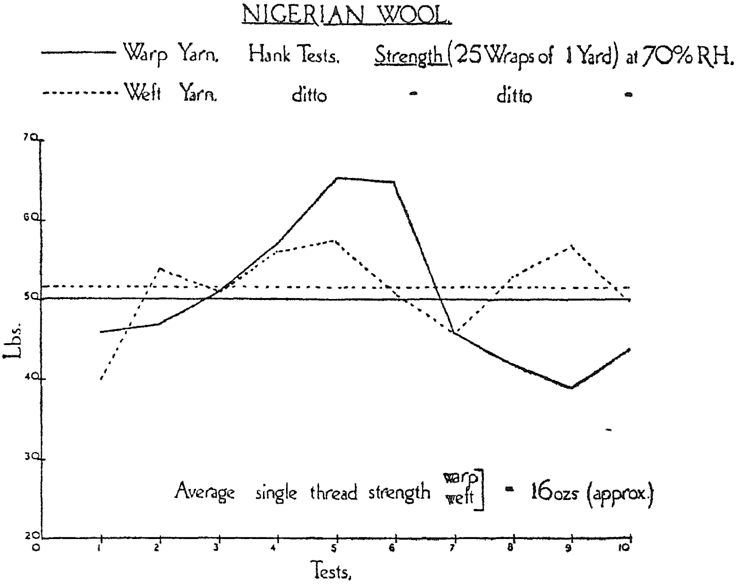
GRAPH IA.



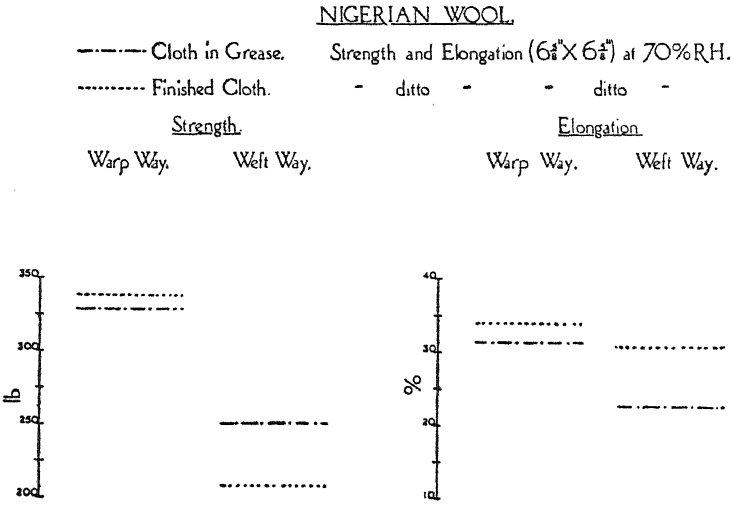
GRAPH. 2.



GRAPH 2A.



GRAPH 3.



GRAPH 4.

Taking the results of Table III collectively, it is found that, although the dyeing and finishing has reduced considerably the strength and elongation of the warp and weft yarns, there is an increase in the finished cloth strength and elongation warp way. The cloth strength weft way has been reduced 17 per cent. whilst the elongation has increased very appreciably by 36¼ per cent.

Considering the cloth strengths given in columns 8 and 9 of Table II, the following seems evident :

Cloth in Grease

1. That 38 per cent. of the strength warp way is due to the weft and weave.

2. That 40·5 per cent. of the strength weft way is due to the warp and weave.

Finished Cloth

1. That 44·18 per cent. of the strength warp way is calculated to be due to the warp yarn against 62 per cent. calculated for the greasy cloth, the remaining 55·82 per cent. being due to weft, weave and milling.

Allowing 30 per cent. for weft and weave, the milling has been responsible for 25·82 per cent. or about one quarter of the cloth strength warp way.

2. That 52 per cent. of the strength weft way is calculated to be due to the weft yarn against 59·5 per cent. calculated for the greasy cloth, the remaining 48 per cent. being due to warp, weave and milling.

Allowing 28 per cent. for warp and weave, the milling has been responsible for 20 per cent. or about one-fifth of the cloth strength weft way. The increased strength due to milling is, no doubt, under-estimated in each case, but the values given for the influence of yarn and weave on the strength, based on the figures for the greasy cloth, enable an idea to be formed of the extent to which the milling has contributed to the strength.

Consider now the amount of variability in the yarns given in columns 6 and 7 of Table II.

The warp yarn tends to be more variable than the weft in both strength and elongation, suggesting that, had the

PLATE III

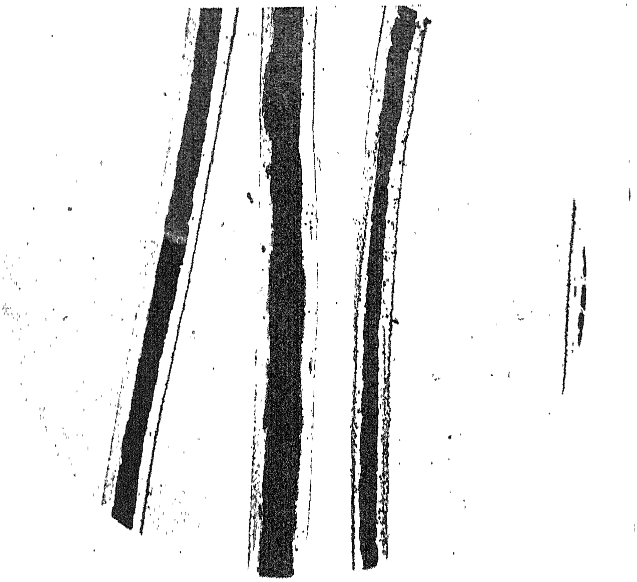


FIG. 1.—Quality A. (× 95.)

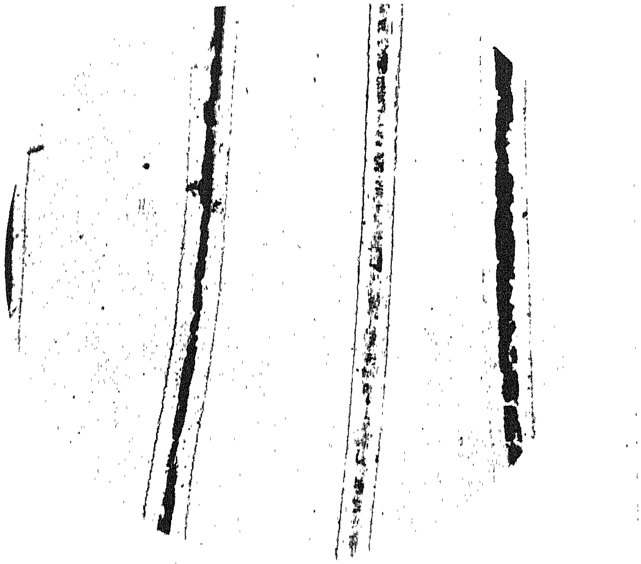


FIG. 2.—Quality B. (× 95.)

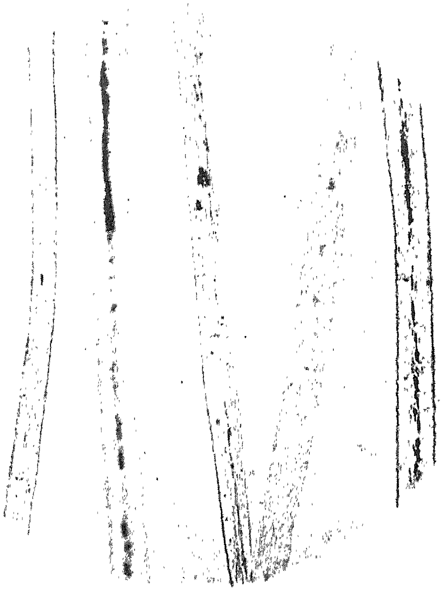


FIG. 1.—Quality C. (× 95.)

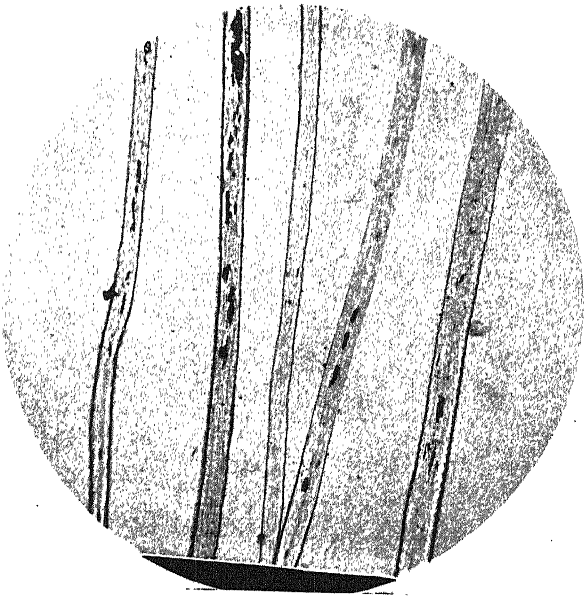


FIG. 2.—Quality D. (× 95.)

material been spun finer, no doubt the variability would have increased quite appreciably.

Referring to columns 6a and 6b and 7a and 7b, the ratios (R) calculated from the normal values in each case indicate, first for strength, that the warp yarn appears to have been slightly more affected by the finishing than the weft yarn, as suggested by the values 1·67 and 1·25. Similarly with the elongation of the weft, which has apparently been impaired by the finishing, as also indicated by the values 1·04 and 0·88. In the case of the weft, the increase in variability of both strength and elongation is to be expected owing to the bursting during milling, but at the same time the figures indicate that the milling has not been severe.

In the case of the warp, however, it is not expected to supersede the weft yarn in this respect, hence there appears to be further confirmation of the fact that a count of ten skeins is the practical spinning limit or perhaps slightly beyond for this type of fleece.

Specimens of the cloth can be obtained on application to the Secretary of the Wool Industries Research Association, Torridon, Headingley, Leeds.

The photomicrographs A, B, C and D (Plates III–VI) will convey some idea of the quality of fibre in the fleece, and as a result the difficulty in carding and spinning will be appreciated.

The work in this direction is being pursued with the object of sorting the fleeces and producing different types of cloth.

Conclusions

From a practical and technical point of view, this wool is considered to be adequately suitable for low and medium class woollen cloths, particularly of the homespun type.

This wool has good shrinking and milling properties, its hank strength for this count is up to standard and its scoured yield is about 85 per cent.

Trade Opinion

The cloth has come out remarkably well. The general feeling is, that if the yarn could have been spun finer and woven to about 16/18 ounces, instead of 24 ounces, it would have made a good sports suiting, otherwise it makes a splendid overcoating.

Report, 1930

Mr. S. B. Hollings, of Bradford, the well-known wool expert, examined the fleeces. He was very enthusiastic about them and said that they were the foundation of something very good.

He commended the absence of coloured hairs, also the good wool in the fleece, stating, in fact, that it was far better than most African wools.

As to the future, Mr. Hollings said that he strongly advised an experimental crossing with a Leicester, Wensleydale or Dorset Horn ram. He thought this crossing would give a bigger body and possibly a longer staple.

Report, 1931

"I have to-day carefully examined these Nigerian fleeces and note with pleasure the marked improvement compared with the fleeces examined twelve months ago. I remember them clearly and the two fleeces seen to-day seem to be moving in the direction of real commercial value. I am very pleased with the cross which has been adopted.

"Fleece No. I. This shows very good breeding in parts, but is mostly tender. Perhaps the age of the ewe may have had something to do with this, but the wool is quite useful and would be more so if the weakness could be eliminated. The britch end of the fleece is very coarse and kempy, and, of course, if you had any weight of the wool, the fleece would have to be skirted and these low parts removed and baled separately. However, I am satisfied that there is a commercial value in this fleece. It could easily be used in the woollen and hosiery trades, that is, the finer parts, but it could also be used in the production of carpet yarns.

"Fleece No. II. This is a ram lamb half-bred Southdown. Really these are lambs. Here again there is a certain portion that is very good quality, but the britch end is very low, coarse and kempy. Wools like this would

PLATE V

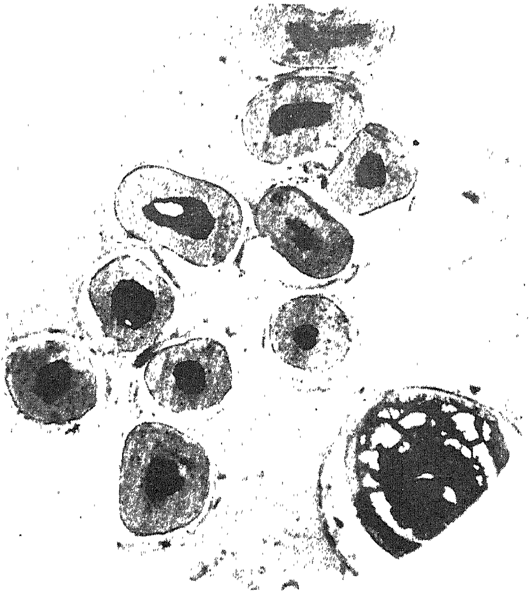


FIG. 1.—Quality A. (× 200.)

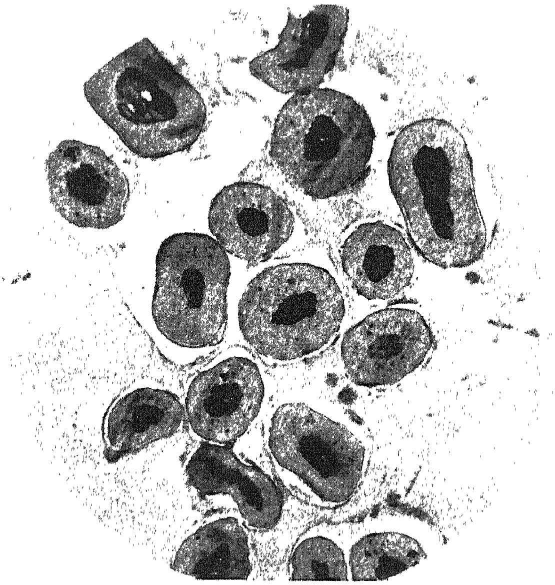


FIG. 2.—Quality B. (× 200.)

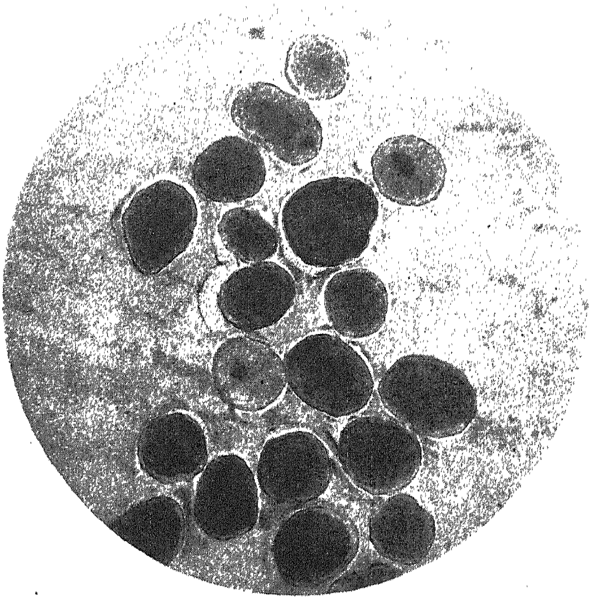


FIG. 1.—Quality C. (× 200.)

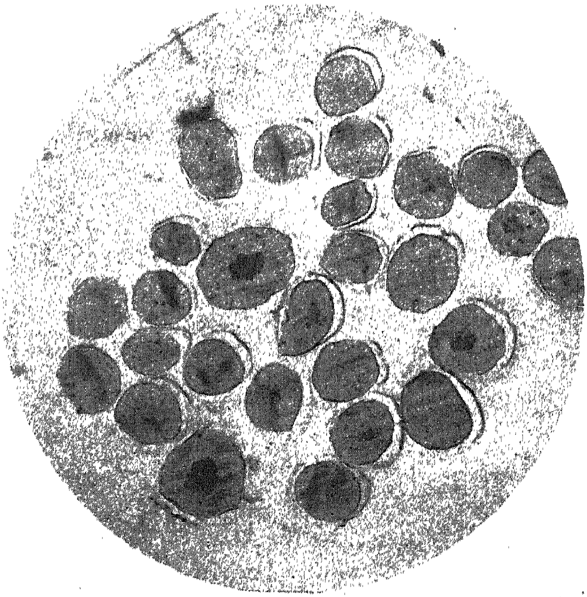


FIG. 2.—Quality D. (× 200.)

have to be used in the production of carpet yarns, blankets or tweeds, and two distinct lots could be made out of these fleeces. I think finality has not yet been reached in the breeding of sheep and the growing of wool in Nigeria. Certainly, Sample II has a fair amount of economic value and the cross-breeding experiment is well worth trying on a larger scale.

" (Sgd.) S. B. HOLLINGS,
" March, 1931."

Acknowledgments

We wish to acknowledge our indebtedness to Captain W. W. Henderson, Chief Veterinary Officer, Nigeria, for suggesting the possibility of the utilisation of this wool and affording us facilities for investigating its characteristics.

We also record our thanks to Mr. R. E. Montgomery, Adviser on Animal Health to the Colonial Office, London, for information and photographs so generously placed at our disposal.

The test length was scoured, dyed and finished by Messrs. Bullus, Grey & Co., Ltd., Meanwood, Leeds, to whom we are very grateful.

The authors are indebted to Mr. J. Barritt for the gross scour test on the wool; to Mr. C. G. Winson for the photomicrographs and to Miss F. M. Briggs, who has very ably assisted in the technical section.

THE FIELD FOR SISAL RESEARCH IN EAST AFRICA

BY F. J. NUTMAN, A.R.C.S., M.Sc., D.I.C.

East African Agricultural Research Station, Amani

THE cultivation of sisal (*Agave sisalana*) is of great and increasing importance in East Africa, the total exports of the fibre reaching 51,856 and 64,387 tons in the last two years. The acreage involved in the year 1929 was 270,511 as nearly as can be gathered from official records, and, until the recent heavy fall in prices, the area was rapidly extending.

Sisal is a crop on which practically no research has been carried out. It will grow well in most situations with the minimum of attention and, in the past, prices have been sufficiently high to allow of profitable working with the minimum of scientific knowledge.

During the years 1929 and 1930 the writer has visited a number of estates in Tanganyika Territory and in Kenya, with a view to making field observations and to investigating the scope for research on problems of fundamental importance. These problems are so numerous and of such interest that it is thought advisable to draw the attention of workers to the vast and unexplored field for research which exists here. Problems of agronomy, physiology and genetics abound: and it is hoped to attack some of these from Amani, working in conjunction with the projected Sisal Research Stations.

It must be remembered that sisal is not an annual. Hence field research is lengthy, laborious and expensive. One is unable to carry out an experiment in a few months of concentrated effort—a minimum of five or six years being necessary in handling the majority of problems. Even so, the importance of sisal as a crop makes such experiments well worth while. In addition to problems needing field experimentation, much work is required under more controlled conditions, especially with regard to the water relations of the plant.

This article is mainly concerned with physiological problems, those of genetics and of agronomy being, of necessity, dismissed in a few lines. It should be remembered that these offer an even wider field for work. It may be stated that nothing at all is known on the genetics of sisal, while the agronomic treatment of the crop is, in general, a matter of personal opinion. From the physiological standpoint the following questions are of interest.

(*a*) What are the causes leading to "poling," the initiation of the fruiting phase in agaves? Can this be postponed or hastened? Are soil and/or climatic factors correlated with the time of incidence of the flowering phase? If so, how?

(*b*) What factors lead to seed production in sisal?

Why does the sisal plant not set seed under normal conditions ? Can fruiting be artificially induced ?

(*c*) What factors cause the production or suppression of " suckers " ? What is the effect of suckers on the parent plant ? What is the physiology of the system " plant-sucker " ? What stimuli are transmitted from one to the other, and how and when are they transmitted ?

(*d*) Is the sisal plant as resistant to drought conditions as would be supposed ? What are the water relations of the plant ? If varietal drought resistance exists, what is its physiological basis ?

(*e*) What are the factors determining fibre yields ?

(*f*) What are the mineral requirements of the plant ? Are fibre yields correlated with soil differences ? If so, in what way ?

It will be found convenient to deal with these questions seriatim, giving where necessary the relevant field data that have been collected, and indicating tentative hypotheses which might form a basis for the solution of some of these problems.

The sisal plant, in common with other agaves, grows vegetatively for a number of years, producing leaves which are periodically removed and which form a source of the sisal fibre of commerce. When flowering is about to begin, the terminal bud, previously deeply buried in the young leaf bases, starts to shoot, and produces a tall mast-like stem, with a number of lateral flowering branches near the top. After the pole has emerged, no more leaves are formed, and the plant dies more or less rapidly according to the situation. In Yucatan fifteen, in India ten, in East Africa four to eight years, will see the death of the plant. All plants which have poled have to be dug out or chopped down, and new plantings made at considerable expense. The young plants do not come into bearing for some years. Is poling inevitable ? It has been stated that the sisal plant automatically poles after producing a given number of leaves. This is not so. Leaf counts of normal poling plants, even in one area, show considerable variation in the number of leaves produced prior to poling. When areas which are more widely separated are considered, the differences become much greater. *Agave*

Cantala Roxburgh under coastal conditions in Tanganyika rarely poles at all. At least, I have searched the only area of cantala on the Tanganyika coast without finding a pole. It appears possible that under appropriate conditions sisal could be grown for many years without producing a pole at all. What are the causes of poling? If this question could be answered, alterations to current practice of great practical importance might be made. Observation shows that a very marked acceleration of poling is produced by a delay in cutting the leaves of the plant. On two estates this effect was noted, and on a third, situated between Tanga and Pangani on the Tanganyika coast, conditions favoured a more detailed survey. Here the land had gradually been planted up in a direction from south to north and the cutting of the leaves had proceeded regularly in the same direction. Observations were made on the poling at intervals of 200 metres across the estate. At the southern end it was found that about 25 per cent. of the plants had poled; 200 metres to the north the percentage was 20, at a further 200 metres 15, and at the next 200 metres 10. This steady poling gradient which runs across the area is probably to be correlated with the age of the plants, those at the southern part being older. At 600 metres from the southern end cutting had been temporarily discontinued for estate reasons, and at this spot it was observed that a very marked rise in the percentage of poles occurred, the figure being as high as 42 per cent.; 200 metres farther on it had fallen to 33 per cent., whilst the final figure, at the next 200 metres, i.e. for the youngest plants, was only 6 per cent.

What explanation can be made to meet these facts? Is the carbohydrate nutrition, the water relation, the removal of reserve supplies in the leaves, the cause of this effect? A belief exists that sisal will pole earlier in rich soil and certain field observations bear this out: one would also expect that the water relations of the plant would affect the date of poling.

Sisal does not, normally, set seed. One or two figures of sisal seed pods exist; but, to my knowledge, regular fruiting has never been recorded. Mumford, in *Agaves of the United States*, gives dimensions of the capsule, while

PLATE VII

FRUITING OF SISAL IN THE KENYA HIGHLANDS

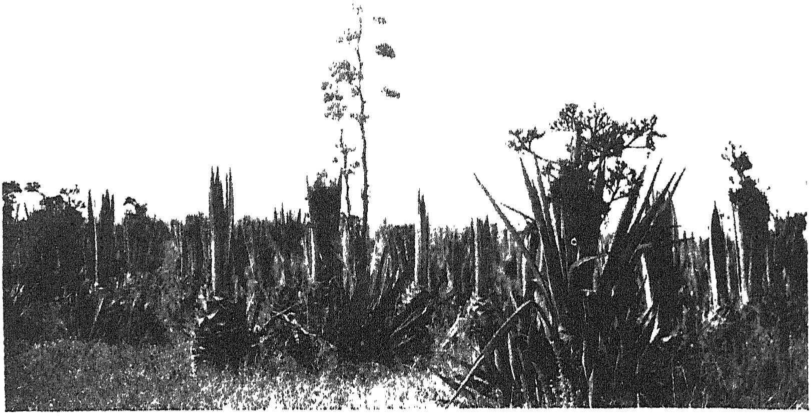


FIG. 1.—A cluster of laterals, bearing flowers, bulbils and capsules, surrounding the cut pole of the plant, is seen in the foreground to the right, and uncut poles with flowers and bulbils, but with no capsules, in the centre.

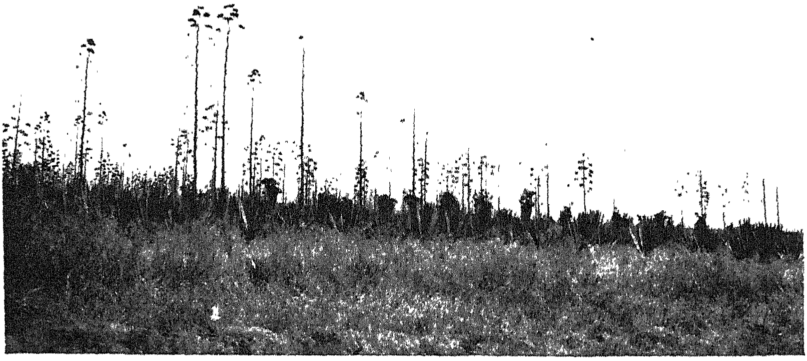


FIG. 2.—Showing the numerous fruiting clusters round the cut poles, and the much taller, uncut poles.

other writers state that seed is unknown. In all parts of the world, the lateral branches of the pole produce numerous flowers, which absciss early, and are followed by an enormous crop of bulbils, arising from the axils of scale leaves just below the flowers. From 2,000 to 4,000 bulbils are produced on a single pole. These are largely used for planting purposes. When the poles are cut short, bulbils often grow in a cluster from the cut end of the shoot. On the coastal plains of East Africa no seed capsules have ever been seen by the writer.

At its highest range in the highlands of Kenya, however, sisal produces abundant fruit at nearly all times of the year. Only one sisal estate is situated in the fruiting zone, and hence the limits of the conditions inducing fruiting cannot be given. Those prevailing on the estate in question are as follows : the altitude is 6,300–6,500 ft., and the soil is a grey volcanic ash. The rainfall is low, and the plants are grown under semi-desert conditions. In fact, sisal culture in this place can only be characterised as dry-farming.

From seed obtained from Kenya, some thousands of sisal seedlings (the first recorded ?) have been raised at Amani and are forming a basis for detailed study. It is of interest to note that fruit, even under these conditions, is never found on uncut poles. It is the normal estate practice to cut the young pole out soon after its first appearance, in order to mature the remaining leaves. In the highlands, the buds in the axils of the scale leaves of the basal portion of the pole push, and produce a cluster of lateral branches, comparable in size to those normally produced at the top of an uncut pole. These branches flower profusely, and set seed freely. The flowers which do not set drop off as usual and are followed by the normal crop of bulbils. Hence the top of the pole is clustered round with a dense mass of branches, bearing both seed and bulbils in large numbers. On estates near Nairobi, at altitudes of about 5,000 ft., the pushing of the laterals on a cut pole takes place to a limited extent. I have frequently noted flowers with considerably swollen ovaries at this altitude, but have not seen fruit. Under coastal conditions the pushing of the laterals is very uncommon. One or two cases have been noted, but the branches produced are never more than two in number, are very small, thin and weak and do not set seed.

The problems involved in the fruiting of sisal are of considerable interest and complexity, and are also of some fundamental importance. In putting forward a very tentative hypothesis as to the causes of fruiting, it is well to distinguish between conditions tending to induce the reproductive phase and those which favour the setting of the fruit. It must be remembered that flowering of sisal takes place all over the world, and that, therefore, the conditions leading to flowering are common. Yet in only one place has seed production been recorded, though it must be remembered that a transition between the obstinate unfruitfulness of the plains and the fruiting in the highlands is to be seen. Two observations of the writer which may have a bearing on the problem are as follows—flowers in the highlands absciss much less readily than on the plains. On the plains the regular line of abscission is very clearly marked, and flowers in all stages absciss readily along that line with the application of a little force. This regular line of abscission is not so well marked up-country and, where flowers are broken from the stem by force, the fracture is often irregular and at an angle to the normal abscission. It is therefore conceivable that fruiting is dependent on the absence of conditions which cause the abscission of the fertilised ovary. There is yet to be explained the fact that no fruits are produced on uninjured poles, whereas on the cut ones they abound. What stimulus, due to wounding or to other causes, prevents the normal abscission of the flowers ? It appears possible that less water is available to the flowers on the uncut poles. By the time they are fully developed the base of the plant and part of the pole itself is dead and dry. Whereas, the plants whose pole has been cut are still alive and green at the time of fruit production. It must, however, be kept in mind, that, on uncut poles, the conditions are suitable for the production of bulbils in considerable quantities. The incompleteness and the unsatisfactory nature of this hypothesis is only too well realised. But up to now it appears to be the only one which will fit the facts as they are at present known.

The sisal plant, in addition to bulbils, produces suckers which arise from underground stems. These stems can be of some length: and new plants can be formed many yards away from the parent. The variation between adjacent areas on apparently similar soil, and planted at the same time from similar material, with respect to the numbers of suckers formed per plant is remarkable: and leads to enquiry as to the causes of suckering, also to whether, as has been asserted, suckering is injurious to the parent, draining its food reserves, or whether, as appears possible from fragmentary field data, the presence of a number of suckers tends to retard poling. The result of this suckering is that a system arises of a parent plant, surrounded by a ring of suckers, each with a more or less well developed root system of its own, yet attached to the parent by a rhizome which does not, in general, die off until the death of the parent. This system behaves rather remarkably, the behaviour being correlated with soil, rather than with climatic differences. In some places the suckers develop normally, as indeed they always do if removed from the parent and planted out in the field. In others the influence of the parent plant on the offspring is very well marked, as on its poling a tendency is transmitted to the suckers to pole likewise, often at an absurdly early age. It is not uncommon to see a poling plant surrounded by a ring of poling suckers, with miniature poles ranging from 2 to 15 ft. high, according to the size of the sucker. No poling suckers have ever been seen by the writer attached to non-poling parents. When small suckers, with rudimentary poles, are removed from their parent plant and replanted, a resumption of vegetative activity takes place. What is the nature of the stimulus causing poling of the attached suckers, and when is it transmitted? It appears possible that, as well as obvious stimuli, such as that causing poling, others, less apparent perhaps, might well be transmitted. If this be so, then suckers removed at different stages in the life of the parent would probably have widely different life histories. I see no reason, when the appropriate knowledge is obtained, why the parents should not be treated culturally in order to transmit the appropriate stimulus to the sucker before it is planted out into the field or nursery.

The problem of drought resistance in sisal is a very real one. There is at present a tendency for the planting of sisal to be extended to the more arid inland parts of East Africa, where its drought-resisting qualities make it one of the few crops which will grow. In such conditions, however, symptoms of undue water strain are very evident. A striking effect is produced in certain areas of low rainfall and semi-desert conditions, where sisal has been planted over the site of an old road, motor track or even game trail. The forgotten pathways are recorded as lines of greener and better sisal winding over the plains. Even the movements of the tractors used in transporting planting material are thus perpetuated. This is clearly due to the compacting of the soil, leading to an increased supply of water to the rather superficial root system. Under such conditions as these, varietal drought resistance is clearly seen. Of the physiological basis for this, nothing is known. Sisal growing under semi-desert conditions involves wide spacing, frequent cleaning and extensive cultivation, leading to considerably increased costs of production.

The opinion is widespread that sisal grows better and produces a higher fibre content in limestone soils. An opportunity was afforded to examine an experiment which had been laid out on a coastal plantation in Tanganyika where varying dressings of lime had been applied. No difference was measurable between the limed and the control plots in any respect. This result should not be taken to mean that sisal does not grow better in limestone soils. The fact is merely recorded that liming of soils, under coastal conditions, has no effect on sisal. As many of the coastal soils overlie coral rag, it is possible that enough calcium was already present in the soil, assuming the alleged superiority of limestone soils to be due to the presence of quantities of calcium. Even so, the whole question of the manurial requirements of sisal, and of the effect on fibre production of the mineral constituents of the soil, offers a field of its own well worth exploration.

Sufficient has been said from the physiological viewpoint to indicate the wide field for research on a variety of problems which is afforded by sisal. Problems of agronomy are not less important and numerous. Little solid knowledge of the effects of spacing, cutting methods, propagation and cultivation is available. Spacing varies from 2,000 to nearly 9,000 plants per hectare. In addition, the normal and the Sumatra methods of laying out plantations exist. The normal type of planting consists of evenly spaced rows: the Sumatra, of paired, closely spaced rows, each pair being separated by a space wide enough to admit of tractor cultivation. Cutting methods vary as widely. Correlation between cutting and poling has been shown to exist, and suitable cycles can only be worked out by experimentation, accompanied by accurate costing. Plantings are made from bulbils or suckers with little evidence for the superiority of either. Cultivation appears essential in one place, immaterial in another, and so on.

Genetical problems also abound. All the sisal in East Africa has been vegetatively propagated from very few importations. Yet well marked varieties undoubtedly exist. The writer has observed bud mutation in sisal, and, in the thousands of millions of plants in East Africa, this must have occurred frequently. Considerable variation also occurs in seedlings, opening a wide field for selection.

At the time of writing, the sisal industry of East Africa is passing through an anxious period. Work on the plant itself, of considerable fundamental importance, will not only add to our knowledge of a group of plants about which singularly little is known, but will inevitably benefit the industry to an extent which cannot well be over-estimated.

NOTES

The Sugar-Beet Industry.—In view of the fact that the British sugar-beet industry has now entered upon the third and last stage of the subsidy granted under the British Sugar (Subsidy) Act, 1925, it was considered that sufficient experience had been gained to enable a survey of the progress of the industry to be made. The Ministry of Agriculture and Fisheries therefore invited Mr. Alfred Wood, as representing the industry, to take part in the preparation of such a survey jointly with Mr. J. H. Gorvin, C.B.E., of the Markets Division of the Ministry. Mr. B. A. Forster, of Messrs. Czarnikow Ltd., a Director of the Anglo-Scottish group of beet-sugar factories, was invited to assist them in a consultative capacity. The report of their investigations has recently been issued under the title "Report on the Sugar-Beet Industry at Home and Abroad" (*Report No. 27, Econ. Series, Min. of Agric. and Fisheries*, H.M. Stationery Office, 1931, price *6d.*).

In addition to giving a brief historical survey of the sugar-beet industry in all countries where it has become established, the report, which extends to nearly 300 pages, covers every aspect of the industry in this country from the cultivation of sugar beet and the manufacture of beet sugar to the marketing of the finished article. For this purpose the report has been arranged in six parts, including an introductory part dealing with the nature of sugar and its uses, production and consumption. This is followed by an account of the sugar beet industry abroad and the home-grown sugar industry. The third and fourth parts relate to agricultural and factory operations respectively, and then follows a survey of the marketing conditions in this country and price factors.

In a final chapter summarising the progress made in the industry and a discussion of its prospects, consideration is given to such fundamental questions as whether the industry is adapted to the conditions of this country, its national advantages, whether technical and economic progress has fulfilled expectations, and the prospects of the industry. It is concluded that the country is eminently suitable for sugar-beet cultivation, that the crop is of considerable value in the reconditioning and revitalisation of arable land, and that during the prevailing agricultural depression it has been a valuable stand-by as a cash crop. In addition to these agricultural advantages, sugar-beet cultivation has provided employment both on the farm and in the factory.

As regards technical progress, the improvement in the knowledge of the farmer and the field workers during the subsidy period may be regarded as satisfactory, and the technical efficiency attained by the British factories now approximates to that of foreign factories.

In surveying the prospects of the industry, it is stated that, at present world prices, in no country in the world can the sugar-beet industry be maintained on a profitable basis unless supported by substantial artificial aid. It is significant that, in some European countries such as the

Netherlands and Sweden, the industry has recently been afforded a cash subsidy in addition to an existing measure of tariff protection. What the position will be at the end of the subsidy period (October 1, 1934) it is impossible to foretell, but certain internal factors may be mentioned which have an important bearing on the future of the industry if it is to be conducted on sound and progressive lines.

The problem of reconciling the purely home-grown sugar interests and the purely refining interests is still unsolved. An important factor is that the leading firm of sugar refiners has a substantial interest in four of the beet sugar factories. It has been suggested that the best hope for the future lies in the unification either of the home-grown sugar interests, as such, working side by side and in harmony with the refining interests, which have already attained a high degree of unification, or of all sugar interests in this country, both manufacturing and refining, accompanied by satisfactory safeguards for the sugar-beet grower. It would then be a question for consideration whether, in negotiating beet prices, any advantage would be gained by replacing the period of collective bargaining which has previously been adopted, and is only concerned with price-fixing, by a more compact system of collective purchase and sale, in which the contracting parties would be an all-in combination of factories on the one side and an all-in marketing organisation of beet growers on the other.

In any exploration of these problems, the question of factory capitalisation is one of the most difficult. As is shown, on the one hand the capital of many of the factories consists substantially of guaranteed mortgage debentures ; on the other the assets of most of the remaining factories are unencumbered, the capital consisting entirely of shares subscribed by private investors.

Through economic pressure, if not as a result of voluntary action, a solution of these problems may be found before the subsidy expires. In any case, the sugar-beet industry should be able to prove, by 1934, that, judged by its standards of accomplishment and by the structure and virility of its organisations, it has been fully worthy of public support.

Manila Hemp (Abacá).—A monograph by M. M. Saleeby, entitled, " The Standard Grades of Abacá ; their Causes, Origin and Influence on Production," has recently been issued as *Bulletin No.* 1 of the Fiber Standardization Board of the Department of Agriculture and Natural Resources of the Philippine Islands. It describes the plant, with special reference to the leaf sheaths from which the fibre is obtained, and gives an account of the fibre, its characters and the methods of extracting it. Particulars are furnished of the standard grades of Abacá, including the characters on which the grading depends, especially cleaning and colour.

One chapter is devoted to the relative proportions in which the various grades are produced and their equivalent values in pesos per picul at a Philippine port of export, in cents per lb. c.i.f. New York, and in £ per ton c.i.f. London. Two formulæ are presented, viz. (1) the " yield formula," by which the actual production in any year can be reduced to terms of one uniform quality, thus facilitating a comparative study of the equivalent productions over any number of years, and (2) the " price formula," by means of which it is possible to make a forecast of the probable tendency towards the quality or qualities of future production.

It is pointed out that during the past ten or fifteen years the Abacá industry has been threatened from various directions : (1) the production of satisfactory qualities of Manila hemp on a small but increasing scale in some tropical countries ; (2) the increasing production of sisal in East Africa and the Dutch East Indies ; and (3) by recent improvements effected in the qualities of henequen (Mexican sisal). In view of this, the concluding chapter of the work indicates the reforms and improvements which are necessary to enable the Philippine industry to withstand such competition.

Among the agricultural improvements required are the complete abandonment of certain fields ; the renewal of old and depleted fields by replanting under modern methods of cultivation and soil treatment ; and the adoption of the same modern methods of cultivation on the comparatively young fields in which the soil is still rich and the plants are still young and vigorous enough to respond to proper care and treatment. Such a programme, if properly and efficiently carried out, would undoubtedly result in a reduced acreage, but the assured increase in yield would more than compensate for this.

Certain industrial reforms are also necessary. These include the elimination of waste in stripping and the more general use of modern machinery for extracting the fibre. Further improvements suggested are the preliminary sorting or grading of the fibre in the localities of production ; the standardisation of the stripping knife or blade ; and simplification of the standard commercial grades by amalgamating some of the higher grades and by eliminating some of the coarser grades.

The monograph is illustrated with nineteen excellent plates, including coloured reproductions of the fibre of the principal standard grades, and it will doubtless be of great service to all interested in Manila hemp from either a commercial or industrial standpoint. Copies (price $1.50 each) are obtainable from the Bureau of Printing, Manila, P.I.

International Congress of Timber and Sylviculture.—The Congrès International du Bois et de la Sylviculture was held in Paris from July 1 to 5, 1931, under the auspices of the International Colonial Exhibition (1931). The principal objects of the Congress were to bring together persons interested in forest protection and the production and consumption of timber; to consider the economic, technical, industrial and commercial questions involved, with a view to international agreements and standardisation; as well as measures best adapted to the conservation and improvement of forests, the restoration of denuded areas and the utilisation of vacant land; and to discover better methods of handling woods and of utilising forest products.

The Congress, which was inaugurated by an address from M. Achille Fould, Under-Secretary of State for Agriculture, was largely attended, the sessions being held in the Pavillons des Bois Coloniaux and the Cité des Informations of the Exhibition. The majority of the delegates represented France and the French Colonial Empire, but one hundred and fifty delegates also attended from twenty foreign countries. The British delegates comprised representatives of the High Commissioner for India, the Forest Products Research Laboratory, Princes Risborough, the Imperial Forestry Institute, Oxford, the Royal Botanic Gardens, Kew, the University of Edinburgh, the Timber Trade Federation of the United Kingdom, and the Imperial Institute.

The Congress was organised in four Groups dealing respectively with the following subjects: *Group I*, Tropical and Sub-Tropical Woods; *Group II*, Sylviculture, Forest Management, Forest Economics and Legislation; *Group III*, the Timber Trade and Industry, and International Relations; *Group IV*, Technical Education.

Some 150 papers were presented to the Congress, and of these about sixty were read and discussed. Attention centred largely around Group I, which was organised by the Comité National des Bois Coloniaux and held its meetings under the chairmanship of M. Jean Delpech, Membre du Conseil Supérieur des Colonies. The Group was divided into five sections. Papers contributed to Section 1 (Sylviculture and Wood Technology) dealt with the management, improvement and reconstitution of tropical forests and evoked much discussion by French authorities. Italian delegates spoke on forestry problems in the Italian colonies, and on the fixation of sand dunes in Tripoli. Papers were read on the forest flora of Central Africa and on the influence of forests on rainfall, and a series of contributions dealt with methods of identification of timbers and the physical and mechanical properties of wood. Section 2 received papers relative to the production of tropical woods, the prospecting and regulation of timber concessions and methods of exploitation, including contributions dealing with the use of railroads for evacuating timber from the forest. Questions affecting transport and shipment of timber were discussed in Section 3. Section 4 dealt with commercial subjects, including markets, stocks, measurements, conversion and standard nomenclature, and received communications relating to the markets for colonial woods in Germany, Belgium, France, Great Britain and Italy. In Section 5 the papers read were concerned mainly with the utilisation of tropical woods.

The contributions of the British representatives were read before *Group I* and comprised the following papers: Forest Vegetation of South Central Africa (J. Burtt Davy, Imperial Forestry Institute, Oxford); The Position of Timber Anatomy in the Study of Forest Products (B. J. Rendle, Forest Products Research Laboratory, Princes Risborough); The Influence of Forests on Rainfall and Water Supplies (E. P. Stebbing, University of Edinburgh); Tropical Timbers in the Markets of the United Kingdom (W. C. Potter, Timber Trade Federation), and the Utilisation in the United Kingdom of British Tropical and Subtropical Woods (S. E. Chandler, Imperial Institute).

Of the resolutions approved by the Congress for submission to the appropriate authorities, those adopted at the instance of Group I included recommendations concerning (1) measures for the exploration, protection and improvement of forests, the preparation of "forest floras," and the technical study of tropical woods; (2) regulations affecting the exploitation of timber and improved methods of timber production; (3) improvement of the accommodation and handling of timber stocks at the ports and on board ship; (4) standardised nomenclature of tropical and subtropical woods, and the need for the maintenance by importers of stocks of approved colonial timbers; (5) research into the industrial utilisation of timbers. These resolutions included two proposed by J. Burtt Davy (Oxford) relating, respectively, to the need for the creation of forest reserves on the watersheds in tropical Africa, and the publication of an international list of tropical and subtropical trees.

Considerable attention was given to the subject of the microscopical anatomy of timber, and the Congress was made the occasion for the second conference on wood anatomy provided for at the Cambridge meeting of the Fifth International Botanical Conference, 1930. As a result of the discussions it was decided to constitute an International Association of Wood Anatomists.

A notable feature of the Congress was the active interest taken by leading members of the French timber trade in the organisation and proceedings of the Conference. This interest culminated in the visit paid by the delegates to the port of Le Havre which, since the war, has greatly increased in importance as a market for tropical timbers and in recent years has been equipped with extensive modern accommodation for the import and storage of supplies. Under the guidance of M. A. Charles (of MM. A. Charles, timber importers, Le Havre), the delegates visited the establishment and timber stores of the firm mentioned and also the accommodation and stocks in the warehouses of the Port Authority. A remarkable collection of timbers from many parts of the world was inspected.

This brief note makes no reference to the work of the groups devoted to purely commercial aspects of the timber trade and to the recommendations resulting from the discussions. An official account of the proceedings of the Congress and of the Resolutions adopted is to be published in due course.

Plant Breeding Abstracts.—Under this title the Imperial Bureau of Plant Genetics is now issuing a quarterly publication in which the more important current literature dealing with plant breeding and the genetics of crop plants is abstracted. The references are classified according to subjects, each being followed by an indication of the contents of the paper. The papers are divided into two categories, viz. those published in the British Empire and those published in foreign countries. Papers written in foreign languages are usually abstracted somewhat more fully than those in English. Each item is furnished, for indexing purposes, with its appropriate number in the International Decimal Classification.

The annual subscription for the publication is 5*s*. post free, single copies being obtainable at the price of 1*s*. 6*d*. Subscriptions should be sent to the Deputy Director, Imperial Bureau of Plant Genetics, School of Agriculture, Cambridge, England.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

Soils and Manures

Ceylon.—The following is a brief report of investigational work on soils and manures carried out by the Chemical Division, Department of Agriculture, during the period January 1 to June 30, 1931.

(*a*) *Leaching and Drainage Trials.*—The 1930 results confirm generally those obtained in previous years. The amounts of fertilising constituents lost from the cropped pots are, as previously, quite insignificant ; but the losses from the uncropped pots continue to diminish. This is only to be expected. In the uncropped series the losses of nitrogen appear to be least from the nitrate of soda pots. The losses from the controls are, for the first time since the inception of these experiments in 1926, significantly less than those from the manured pots. The experiment has reached a stage when useful and interesting results will be forthcoming.

(*b*) *Field Studies on the Effects of Green Manures on Arable Soils.*—The last sampling of soils from the green manured plots was taken. They confirm what was previously found, viz. that by green manuring in the tropics, the carbon and nitrogen contents of soils may be maintained. This experiment has now been discontinued.

(*c*) *Change in Composition of Green Manures.*—The complete results of the first experiment have been examined. They indicate that under Peradeniya conditions the best time for lopping bushy green manures is just before flowering, and that *Gliricidia* and dadap trees are best lopped every three and five months respectively, if maximum amounts of decomposable green material are to be obtained. A new experiment to obtain confirmation of these results and to get further data has been started.

(*d*) *Nitrification Experiment.*—The results of this were worked out, tabulated and examined. They confirm what has been found previously, viz. that the nitrate contents of soils at Peradeniya are dependent on rainfall, and that the nitrate contents of the plots at each sampling are generally in the following decreasing order: *Tephrosia,* manured, cultivated, control and sugar-cane. The sugar-cane plot has always the least nitrate content owing to the utilisation of the nitrate by the crop.

(*e*) *Silt Investigations.*—The determinations of the amounts of silt carried at different times of the year in the waters of the Mahaweli Ganga near Gangoruwa were resumed after a break of about a year.

(*f*) *Advisory Soil Investigations.*—Investigations were made in regard to the poor growth and yield of palms on two coconut estates. In one case these were traced to a high-water table and in the other to the competition of a heavy leguminous cover with the main crop for the fertilisers applied to the latter. An investigation into the reasons for the poor yields of paddy from fields under the Paranthan Scheme in the Northern Province indicated that lack of clay and bad burning of the jungle were the causes of the trouble.

(*g*) *Chena Experiments.*—The preliminary experiment to determine the soil changes occurring as a result of "chena" or shifting cultivation was discontinued last year. The analyses of the few samples examined indicate that where the upper layers of soil were initially well supplied with organic matter, the burning has diminished the carbon and nitrogen contents of the soils to some extent. After the first crop the top-soils show a slight increase of carbon, due probably to the addition of crop residues; the nitrogen contents, on the other hand, as is to be expected, show an appreciable decrease.

According to the half-yearly Report, January to June 1931, of the Experiment Station, Peradeniya, the end of the fifth year's figures is now available from area A of the soil erosion experiment. The whole area is in the Tea section, with *Gliricidia maculata* interplanted as shade trees of medium height, and comprises six plots: two of these are controls, two under a ground cover of *Indigofera endecaphylla,* and two with (contour) hedges of *Clitoria cajanifolia.* The losses of soil through erosion for the experiment year 1930–31 are as follows: Control plots, 651·4 lb.; *Indigofera* plots, 201·5 lb.; and *Clitoria* plots, 562·9 lb. Compared with the first year, in which the cover plants were not planted, the reduction in soil erosion effected by these two cover crops has been 54·7 per cent. in the case of *Indigofera endecaphylla*, and 35·6 per cent. in the case of *Clitoria cajanifolia*. The calculated losses of soil in the four years in tons per acre are : Control plots, 47·6 ; *Clitoria cajanifolia* plots, 44·4 ; and *Indigofera endecaphylla* plots, 27·5.

Nigeria.—The following Report on the Work of the Chemical Branch for the half-year ending June 30, 1931, has been furnished by the Agricultural Department.

The soil survey work is occupying the entire attention of the staff of the soils laboratory. Up to the present 488 samples have been received, chiefly from agricultural stations.

The routine analytical work comprises mechanical analyses and determinations of soil reaction (*p*H values) and of exchangeable base, carbon and nitrogen contents. This work has been and is being carried out on over 200 soils up to the time of writing.

There is a considerable variation in *p*H values in soils from different parts of the country, the most acid soils being found on the Benin sands at Ogba Experimental Station and on the lignite series at Umuahia, the *p*H value for these being as low as 4·1 in some instances. As would be expected, there is a corresponding deficiency in exchangeable base content on these soils and it is found that cover crops will not do well under the more acid conditions. It is interesting to observe that these acid soils occur in regions of appreciably higher rainfall than the more neutral soils near Ilugun and from the north, and that their acidity corresponds to that found in large numbers of Sierra Leone soils. It is intended to issue a report on the soils from Umuahia in the near future.

An organic combustion apparatus has been set up for the determination of organic carbon in soils. Between thirty and forty determinations have been made and the resulting figures are low, being round about 1 per cent. The carbon-nitrogen ratio seems to be appreciably higher in more acid soils, possibly indicating that bacterial activity may be inhibited to some extent. There are, however, not enough figures to substantiate this at present.

The Agricultural Chemist, Northern Provinces, reports as follows :

The programme of manurial experiments of the last two years is being continued this season, i.e. an attempt is being made to explain why very small applications of farmyard manure have such a remarkable effect on crop yields. From the first year's work and a study of the records of previous manurial yield trials, it appeared that the phosphate content of the farmyard manure had perhaps a considerable effect owing to the poverty of the soils in that constituent. In the second year an experiment which was carried out showed that inorganic phosphatic manure (fine ground rock phosphate) and inorganic nitrogen (calcium cyanamide) applied in the same proportions and to give the same total amounts of P and N as are present in one or two tons of farmyard manure do not give comparable increases in crop yield.

This season a comparison is being made of the effect of farmyard manure with that produced :

(*a*) By an equal amount of organic matter (grass) containing little nitrogen.

(*b*) By such organic matter with the addition of different amounts of readily available inorganic nitrogen.

(*c*) By readily available inorganic nitrogen added to soil alone.

Trinidad.—The following summary of research work on soils conducted by the Department of Chemistry, Imperial College of Tropical Agriculture, during the period July 1, 1930, to June 30, 1931, has been furnished.

Lateritic Soils.—A new method for detecting and approximately measuring the sesquioxide components of soils (including tropical types) by the absorption of alizarin has been elaborated and applied to a study of katamorphosis of igneous rocks in British Guiana and of the genesis of soil profiles from them. The results of this work have been compiled and presented for possible publication.

Laboratory Investigations.—(1) *Ammonium-ion and Nitrate-ion Status of Soils.*—An exact technique, suited to the determination of the ammonium-ion and nitrate-ion status of heavy, unflocculated soils, has been perfected. The methods evolved are in routine use for the measurement of the effect of : (*a*) fluctuating moisture content, (*b*) varying manurial treatment.

(2) *Replaceable Iron and Aluminium in Soils.*—The investigations concerning the factors which control the presence and amount of replaceable iron and aluminium in soils have reached a stage suitable for publication.

(3) *Saturation Capacity of Soils.*—The analysis of factors contributing to the determination of saturation capacity of soils has been concluded. A method has been devised which enables a close prediction to be made of the

capacity of soil for lime from its content of organic matter and clay.

(4) *Soil Acidity.*—The analysis of factors contributing to the determination of acidity in soils is almost complete. A method has been devised which enables a close prediction to be made of the hydrogen-ion concentration of soil from its degree of unsaturation with lime, and its content of organic matter and clay.

(5) An investigation has been begun of the relationship which the *exchangeable calcium* content of tropical soils bears to their content of acid and soluble calcium.

(6) *Routine Determinations.*—The routine determinations of the lime status, and the contents of exchangeable potassium, sodium and magnesium of the soils of the various experimental plots, and of certain standard soil types, are being continued.

Chemical Soil Analysis.—The following account of a special investigation undertaken by Mr. Croucher has been prepared by him.

(1) The hydroquinoline method for the separation and estimation of small quantities of iron and aluminium in solutions containing certain organic radicles has been further developed. By this method these two elements may be separated and determined in the presence of silica. The method has been applied therefore to the examination of the iron and aluminium contents of plant ashes, and of base-exchange leachings from soils. The method has proved more rapid and more accurate (particularly where small quantities of the elements are being estimated) than the standard procedure which involves the initial separation of silica. Attempts have been made to use the method for a rapid determination of the total iron and aluminium content of soils. Further investigation should produce a valuable method.

(2) Many extractions of soils and minerals with sodium and ammonium tartrate under different conditions have been made, with the idea that the soluble iron and aluminium will represent the free or active amounts of those elements present. It is hoped to obtain some relationship between these results and those obtained by the alizarin dye-absorption method.

Physical Soil Analysis.—(1) The technique of the method for measuring the percolation coefficient of a soil, as described by Bouyoucos, has been studied. The method, slightly modified, has been applied to soils of different types.

(2) The technique of the method for estimating "free" water by the use of alcohol and a special hydrometer devised by Bouyoucos has been studied.

INSECT PESTS

Locusts

Gold Coast.—The Department of Agriculture reports that work conducted by the Entomological Division during the invasion of locusts in 1930 has established that a species of *Aspergillus* was parasitic on *Locusta migratoria migratorioides*. Immediately after death mycelium was found inside the thorax and intestines, and masses of yellow conidial fructifications were found to be bursting through the thin skin between the plates below the neck and at the articulations of legs and wings with the thorax. Cultures of the fungus have been diagnosed as a hitherto undescribed form of *Aspergillus flavus*, which develops black sclerotia in culture.

BEVERAGES

Cocoa

Ceylon.—According to the Report of the Experiment Station, Peradeniya, for the half-year January to June 1931, a manurial experiment with cocoa, started in 1923–24, was concluded in March 1931. Sixteen one-acre plots were divided into groups of four plots each ; each group comprised one unmanured control plot and one plot of each of the three following treatments : 250 lb. superphosphate ; 100 lb. muriate of potash ; and 250 lb. superphosphate and 100 lb. muriate of potash—per plot per annum. The results indicate that there is no deficiency of phosphoric acid or potash in these soils and that the application of the manures had no influence either on the yield or on the incidence of pod canker.

Gold Coast.—The Department of Agriculture has furnished the following report of investigations conducted during the period July 1930 to June 1931.

The field trials detailed in former reports have been continued. These include investigations on methods of vegetative propagation of cacao. Work on this subject has been carried out by G. H. Eady during the past two and a half years, and a summary of results appears in a paper in the *Year Book* 1930. It has been established that vegetative propagation is possible but difficult. Budding alone has proved practicable on a sufficient scale. By this method 80 per cent. of successes can be obtained. The conditions for maximum success of the operation may be briefly stated : Budding should only be performed when marked flushes of growth occur, and buds should afterwards be forced into slight growth by heading back the branches of the stock tree. The most satisfactory results have been obtained when buds 3 to 4 in. in length were selected from wood 3–5 years old and inserted into elongated H-shaped incisions in the bark of the stocks as near the ground as possible. Finally the budded area should be painted over with hot paraffin wax.

Other methods of vegetative propagation have been tried with the following results. No success was obtained with cuttings from any part of the plant, nor by any method of grafting yet attempted. Several methods of layering have been experimented with, and a few plants have been successfully reproduced, but the amount of work and supervision required is prohibitive. Inarching is also possible, but as portions of separate plants are used, the method has no advantage over budding, and the latter has proved to be the easier and better method. The investigations will be continued.

The importance of moisture content of cacao beans in connection with storage of cacao was indicated in the report for January to June 1930 (this BULLETIN, 1930, **28**, 471). A short, practicable method of determining the percentage moisture in a sample of cacao beans is therefore of value, and an investigation with this object was carried out by A. N. de Heer (vide *Year Book*, 1930). As a result, a method has been evolved in which the determination of moisture content is very simple, the only data required being the original weight of a sample of 10 beans, and its weight after 24 hours' drying in a steam oven at 100° C. In the investigation, crushed beans as well as whole beans were used, various sizes of samples were tried and the effect of drying at 100° C. for periods ranging from 3 hours to 75 hours was tested. It was found that no time is saved by using crushed beans, that samples of 10 beans give the same result as much larger samples and that the shortest time required for drying is 24 hours. With regard to this last factor, it was found that the mean loss of moisture after 3 hours and 6 hours was 65·4 and 89·5 per cent. respectively, with a great variation between samples. At 24 hours all samples showed a mean loss of 95·8 per cent. with very little variation. Complete drying required 72 hours. Seventy-two hours is too long to be practicable, and as losses at 24 hours are constant, it is justifiable to calculate the moisture content of the sample, using the figure 95·8 as a constant. The following formula is therefore used: Percentage moisture in sample $= \frac{100}{95 \cdot 8} \times$ Percentage loss in weight after 24 hours.

The incidence of Black Pod disease has been studied by H. A. Dade (vide *Year Book,* 1930). Results of a preliminary investigation were embodied in *Bulletin No.* 6 of the Department. This further work, done in more detail, and with better equipment, has produced more exact data and a clearer conception of the situation. The conclusions arrived at in the previous study are confirmed. It is definitely established that Black Pod disease is determined by extreme humidity and by the proportion of actively infectious disease pods on the farm. Other causal factors are stated to be subsidiary in that they are active only as a result of one or both of these main factors. These include canker, in that canker may be regarded as a legacy from external conditions of humidity and infectious foci of the previous season, and is ultimately subject to the same control as other infections. Methods of control recommended in the past were also confirmed. As control of humidity is impossible, spread of infection can only be controlled by prompt removal of pods in the early stages of disease.

J. Wright, in an examination into the possibility of *Phytophthora palmivora,* the causal agent of Black Pod disease, living saprophytically over the dry season, has come to the following conclusion. In the soil *P. palmivora* has been found to be slowly exterminated by soil saprophytes. On the other hand, it has been found to have a continued existence in diseased husks, where it is still strongly virulent after six months. In consequence, he suggests burial of husks as a control measure of the disease.

The new species of *Mucor,* described by R. H. Bunting in " Fungi Occurring in Cacao Beans " (Paper VIII, *Year Book,* 1928), has now been fully described by Lendner in " Deux Mucors Nouveaux," *Bull. Soc. Bot. de Genève,* 2^{me} Ser., 1930, and has been named by him *Mucor Buntingii.*

Nigeria.—The following Report on the work of the Mycological Branch for the half-year ending June 30, 1931, has been furnished by the Agricultural Department.

The fermentation experiments which have been carried out indicate that good fermentation can be obtained by very unlaborious methods, and samples which were changed only twice or three times during the fermentation process have been favourably reported on by brokers at home. It is felt, however, that further trials ought to be carried out and more information obtained about native methods of fermentation in pits and heaps before a final report is issued.

Several commercial consignments of cocoa have been examined for the presence of moulds and also for the percentage moisture content. The moulds present were principally of the *Aspergillus glaucus* group, but only a very small percentage of mould was found to be present in the samples examined. The beans were from the stores of an exporting firm at Ibadan, Ife and Ilesha, and arrangements were made whereby samples from the same bags should be forwarded to the Field Biological Station (Imperial College of Science) at Slough for further determination of mould and insect incidence and moisture content.

For the experimental work on the control of Black Pod disease of cocoa, after many preliminary examinations of numerous cacao farms, some were eventually selected near Orile-Odo and Ajia villages on the Ijebu-Ode Road. These were arranged in pairs for treatment and control. The plots were marked out and measured and are exactly equal in area. The trees in the treated plots were well pruned, and if too closely planted some were cut out. The following treatments are being given : (1) Methods of good sanitation including complete removal and burial of all black pods. (2) Spraying with Bordeaux mixture (4-4-50 strength). (3) Dusting with fine sulphur precipitated and later " Olite." (4) Dusting with copper carbonate. There is in addition one small plot where no special treatment is given apart from the initial pruning. In all cases the control plot is subjected only to ordinary native cultivation. Treatment with sprays and dusts has been carried out once only, but the operation will be repeated during the short dry season in August. The Bordeaux mixture adhered quite well in spite of heavy rain (2·5 in. of rain fell during this period). Sulphur also was retained in part, but the copper carbonate was readily washed off and may be regarded as unsatisfactory for the conditions prevailing here.

It is not possible to state yet whether the treatment has any beneficial effect, but generally one can state that the trees on the treated plots have a healthier appearance and in some cases give promise of a better crop than do those on the control plots.

Meteorological records are kept by means of Edney's thermohydrographs and the weekly rainfall is also measured. One effect of the pruning has been to raise the temperature and decrease the humidity, particularly the day-time humidity within the treated plots. Crop records will commence with the harvesting of the main season crop.

Trinidad.—The following summary of research work on cocoa soils carried out by the Department of Chemistry and Soil Science, Imperial College of Tropical Agriculture, during the period July 1, 1930, to June 30, 1931, has been supplied.

(1) In connection with the College Cacao Research Scheme, two half-acre plots have been selected in a "good" and a "bad" cacao area, and the periodic collection of data relevant to the atmospheric and soil factors controlling the growth of the cacao tree has been initiated. Various meteorological and other instruments have been set up within the plots, and numerous soil samples have been procured for systematic laboratory examination.

(2) The study of cacao soil profiles has been continued, but the field work has been narrowed down to a detailed investigation of the soil-types occurring within the Montserrat District of the Central Range of Trinidad.

(3) A visit was paid in April to Grenada, B.W.I., for the purpose of examining cacao soil-profiles and collecting soil samples therefrom. Some 350 samples were obtained; their detailed laboratory examination has been commenced. This work was undertaken with the co-operation of the Trinidad Department of Agriculture.

Tea

Ceylon.—In the half-yearly Report of the Experiment Station, Peradeniya, for the period January to June 1931, it is stated that a drought in February considerably affected the tea area and the plants suffered more severely than has been observed previously for a number of years. During the drought the better appearance of the tea under a fairly dense medium height shade of *Gliricidia maculata* compared with that under a very light shade of *Albizzia stipulata* was particularly notable. Taking other cover and shade plants into consideration, though exact comparison is not possible owing to the differential treatment of the various plots, it may be stated that the tea which survived the drought best was that under *Gliricidia maculata* or *Albizzia stipulata* with or without a ground cover crop, next tea with a ground cover of *Indigofera endecaphylla* but no shade trees, next tea under dadaps (*Erythrina lithosperma*) with no ground cover. The tea with no shade trees and no ground cover crop suffered most severely.

According to the half-yearly report of the Plant Pests and Diseases Inspectorate for the Central Division, for the period January to June 1931, the shot-hole borer (*Xyleborus fornicatus* Eich.) is widely distributed over the tea areas of Ceylon and is found up to an elevation of 5,000 ft. A large and well defined area in the planting districts of Dimbulla, Dikoya and Maskeliya has continued free up to now, although a few estates on one boundary of this area have been found mildly infested recently.

Regulations strictly control the movements of tea plants. The object of the regulations is to protect the above free area as long as possible, and they will be modified at an early date to enable free movement of plants in all other parts of the Island barring the free area, into which no tea plants will be allowed to enter from any area outside.

The incidence of this pest is very heavy in a few districts, and the pest is generally well distributed in all other infested areas.

The tea tortrix (*Homona coffearia* Nietn.) showed a marked increase in the Pussellawa district, and the incidence of this pest in other districts has shown no diminution during the last year. Collection of egg-masses is continued satisfactorily, and the collections and reports for the quarter January to March 1931 show some of the heaviest attacks known so far.

The work on the study and breeding of parasites of this pest is being conducted by the Tea Research Scheme, Ceylon.

New records of the tea termite (*Calotermes militaris* Desn.) were made on a few estates. The pest is doing considerable damage on several estates in Maskeliya district. Treatment with Paris Green has yielded satisfactory results in all cases where its application has not been faulty.

CEREALS

Guinea Corn

Nigeria.—The Agricultural Botanist, Northern Provinces, reports that two strains of guinea corn have been produced which gave increases in yield of 33 and 29 per cent. over local corn. This season these are being tested in large, and small-scale trials. In addition some fifty acres of each are being grown, in order that if the trials proved satisfactory, seed would be available for immediate multiplication.

Guinea corn has been shown to be a highly localised crop, a good strain at one station failing at other stations. Accordingly single plant selections have been made at all stations with a view to producing an improved guinea corn for the neighbourhood of each of our experimental stations.

LEGUMES

Beans

Nigeria.—The Botanist, Southern Provinces, in a report covering the period ending June 30, 1931, states that investigations into the question of local consumption cum cover crop have been continued.

(i) *Lima and Popondo Beans through Late Maize.*—Late Maize was sown on August 27, selections of Lima and Popondo beans were interplanted through the maize a fortnight later. The beans failed to produce any sort of cover or edible crop. This was possibly due to water shortage resulting from competition with the maize.

(ii) *Time of Planting.*—Small plots of the Lima and Popondo selections were sown at fortnightly intervals, beginning immediately after the first rains and continuing till the end of October. Maximum yields were obtained from plots sown after the first rains, at the end of March, and from those sown in late June and early July. Staking the plants was found to increase the yields by from one-third to one-half.

(iii) *Introductions.*—Varieties which are important in European markets have been tried out without success. These beans seem to be unable to adapt themselves to the local conditions.

(iv) *Local Beans.*—A large collection of local edible beans was made. Some of the more promising have been retained for further trial. Where possible, the various types were identified.

The Mycological Branch, Department of Agriculture, reports that two attempts to transmit the mosaic disease of Lima beans by inoculating with the expressed juice from diseased leaves have thus far yielded negative results. A third attempt was abandoned owing to the abnormal growth of the caged plants. These plants were grown from freshly matured seed which had not had a preliminary resting period, and this fact, together with unsuitable climatic conditions (dry season), may be responsible for the freak development of the resulting plants. These were dwarfed and formed bunches of small leaves below the two plumular leaves at the point where the cotyledons had been inserted. If seeds are available from healthy plants the experiment will be repeated.

The Agriculturist Botanist, Northern Provinces, reports that in connection with the search for an exportable bean, seven types were sent to the Imperial Institute for valuation and report. Of these, two Madagascar beans, grown from seed, procured from the Imperial Institute, were the most valuable. The other five, Lima types, were either unsaleable owing to bad colour or were valued at about the same price as Ohtenashi or Rangoon White.

Future work will concentrate on the Madagascar beans, from a cultural standpoint, since at present their optimum place in a rotation is not known, nor the most economical method of production.

FRUITS

Banana

Ceylon.—The following particulars are taken from a report of the Mycological Section, Department of Agriculture, for the first half-year, 1931.

The existence of a disease of plantains in the Kurunegalle district, resembling the Panama disease, has already been recorded by the Section. A similar disease of plantains was reported from Periaveli in the Trincomalee district. Mr. Davidson paid a visit to the area in question and obtained photographs and notes of the diseased plantains in the field. In this case too the symptoms exhibited by the affected trees were identical with those described for Panama disease. From information gathered on the spot the disease was first noticed there after the rains of last year. The disease affected trees of all ages and was said to be most virulent during and just after the rains.

Pending further results preliminary control measures were suggested against the disease. They were along lines similar to those in existence in America and the West Indies against the Panama disease.

Mr. Davidson made isolations from diseased tissues of the trees and again obtained a *Fusarium* as in the case of the Kurunegalle specimens. This *Fusarium* also resembled *F. cubense* in cultural characteristics. As the symptoms exhibited by diseased trees in both districts were identical and as the fungus isolated was in each case apparently the same, it is to be inferred that the fungus responsible for the disease in both districts is the same. Pure cultures of the fungus were forwarded to the Imperial Mycological Institute and to Prof. Reinking for identification of the correct species.

Healthy plantain suckers were obtained from Rambukkana and planted out in partially sterilised soil in cement barrels. When established they will be inoculated with pure cultures of the *Fusarium* in question in order to test the pathogenicity of the fungus.

A full description of the disease was forwarded to all Divisional Agricultural Officers and Plant Pest Inspectors with the request that they should keep a look out for the disease in their areas and inform the division should they come across any cases.

According to the half-yearly report of the Plant Pests and Diseases Inspectorate, Central Division, for the period January to June 1931, the incidence of the " bunchy top " disease of plantains is less at present in the Kegalle district, but continues heavy in the Matale district. It is present to some extent in the Division wherever plantains are cultivated. The aphis *Pentalonia nigronervosa,* which is found associated with the disease, was found in the Royal Botanic Gardens, Peradeniya, on the following plants of the Scitamineæ: *Musa sapientum, M. paradisiaca, M. textilis, M. coccinea, Ravenala madagascariensis* and *Strelitzia* sp. Symptoms of " bunchy top " were confined to the economic species of *Musa.*

In the Southern Division, " bunchy top " disease was reported during the first half-year of 1931, from all areas with the exception of Tissamaharama in the Hambantota district, which continues to be free.

Citrus

Ceylon.—The following statement regarding the progress in experiments conducted at the Royal Botanic Gardens, Peradeniya, is contained in the Curator's Report for the half-year January to June 1931.

Stocks under trial for budding purposes now include the following: Pumelo, Sour Orange, Nataran, F. 4/15 E.S.P. 4/5, Grapefruit, Lime, American Shaddock, and *Citrus megaloxycarpa,* a variety of the Citron. The buddings made on American Shaddock and the Nataran, both stocks of very robust growth, are particularly successful and, when budded well up the stem on the inverted T system, make rapid and strong growth. Buddings on the Sour Orange, Pumelo and F. 4/15 E.S.P. 4/5 make slower growth but take very successfully. Those on the Lime and Grapefruit are slower in making a move and, moreover, the stocks themselves are of slower growth and smaller than the former age for age. Buddings on *Citrus megaloxycarpa* are in the young stages yet and more can be said of this later, but these appear very encouraging.

Stock on Scion.—Though the area available in the Economic Nursery is very small for experiment as to eventual effects of stock on scion, or vice versa, such has been laid down on a small scale. Thirty-three stocks planted in plot B of this nursery, comprising three of each of the following, have been budded with budwood from the best of the Peradeniya Experiment Station Grapefruit trees—E.S.P. 5/3.

3 on Pumelo
3 ,, Sour Orange
3 ,, Nataran
3 ,, F. 4/15 E.S.P. 4/5
3 ,, Grapefruit
3 ,, *Citrus Miaray*
3 on *Citrus Webberi*
3 ,, *Citrus Hystrix*
3 ,, Chinese Mandarin
3 ,, American Shaddock
3 ,, Mindora Lime

These have been budded in situ, the seedlings being planted 21 × 21 ft., and will be allowed to reach maturity in their present positions. The buddings were made in April last and a few rebuddings made in June.

A further area, plot C of this nursery, has been utilised for growing on to maturity, at a distance of 25 × 25 ft. apart, specimens of all the above stocks for supply purposes either of seed or vegetative material, at any later stage should such be required.

Plot D, E and F of this nursery is utilised to establish stocks for budding of Citrus types other than grapefruit. Sixty stocks, comprising 15 Pumelo, 15 Sour Orange, 15 Nataran, and 15 F. 4/15 E.S.P. 4/5 have been planted 21 × 21 ft. and budding is in progress as follows:

3 Washington Navel Orange, on three of each of the above four stocks .	12
3 Malta Orange, on three of each of the above four stocks . . .	12
3 Australian Lemon, on three of each of the above four stocks . .	12
3 Seedless Lime, on three of each of the above four stocks . . .	12
3 Mandarin, on three of each of the above four stocks . . .	12

Washington Navel Orange is reported a difficult subject and to show incompatibility on the Sour Orange stock, and the Sweet Orange type above therefore includes the Malta Orange also. The Experiment Station proposes, it is understood, to bud available varieties within the grapefruit group on certain stocks, and similar work with orange varieties might be considered. The above experiment should show to some degree the compatibility of stock to scion on the main Citrus group, though it is realised the numbers are very small for the purpose.

Regarding compatible and incompatible stocks in general use outside Ceylon, data available indicate the following.

Sour Orange.—Compatible to most varieties including Lemon and Grapefruit and incompatible to Satsuma

Orange and Kumquat, but a complete failure in South Africa for all except a few Lemons.

Sweet Orange.—Compatible to Kumquat Grapefruit and Sweet Orange, but doubtful with Sutsuma, which fruits badly on it.

Citron (of which our Nataran is a variety).—Principal stock used in Egypt for nearly all varieties. (Can be propagated vegetatively also.)

Pumelo (*Shaddock*).—A vigorous root system and a reputation for succeeding in both dry and moist soils. Compatible, and a pronounced success with Lemons in California. Needs further investigation. This appears very suited to Ceylon, however.

Rough Lemon.—Well-rooted system and deep tap root, development of buds rapid on the stock, suited to a light sandy soil also. Compatible to Washington Navel and most other Orange, Grapefruit, Mandarins, Kumquats, Limes and Tangerins. Doubtful with Satsuma Orange and some early Sweet Oranges.

Egyptian Lime.—Produces fruits of excellent quality when used as a stock. Compatible to Sweet Orange and Mandarins.

Freeman states that as regards stocks in the West Indies, the Sour Orange has, generally speaking, given excellent results. At Trinidad, in the budding of numerous varieties of Orange and Grapefruit on the Sour Orange, the only definite indication of incompatibility met with has been in the case of the Washington Navel Orange.

Clone Stock.—Early experiments at Riverside, California, on suitable root stocks for Citrus show that great variability exists among seedlings of the same species or stock plant, and that such influences the orchard trees produced. It is shown that the size of the young budded citrus trees indicates the comparative size of the orchard trees developed from them, and that variation in size of the trees was to some degree influenced by the growth rate and vigour of the individual seedling stocks used in the propagation.

It is also stated that the Sour Orange (the stock most generally utilised) exhibits many variant individuals. Later experiments at Riverside show that this is indeed so, and that a vigorous thinning out and discarding of all weak seedlings from nursery beds reduces this variation.

Whilst most Citrus species and varieties (Sour Orange, Sweet Orange and Grapefruit) are frequently self-pollinated and self-fertilised, cross pollination is also frequent, and, in general, about half of the seedlings produced normally come from apogamic embryos. Where clonal varieties are available the seedlings to a much larger degree are true to type, and it is probably upon such lines that the stock true to type will be evolved for Citrus.

No success anywhere appears to have been attained in the vegetative reproduction of the Sour Orange or Pumelo, two stocks of some concern to us, but better results have been attended in the West with Lemons.

At Peradeniya the Nataran (a variety of the Citron) has been successfully raised vegetatively, but attempts with both Sour Orange and Pumelo have so far failed.

The erection of a Solax propagator is in progress which should assist, by means of additional heat and control of atmosphere conditions, to experiment further in this respect.

SUGAR

Cane

Trinidad.—The following summary of research work on sugar-cane ecology, carried out by the Department of Chemistry and Soil Science, Imperial College of Tropical Agriculture, during the period July 1, 1930, to June 30, 1931, has been furnished.

(1) Studies of the effect of eliminating nutrient ions (N, K, P, Ca, Mg) from a complete nutrient solution applied to cane-plants grown in sand culture have been completed. The effect of the inclusion of aluminium and iron in nutrient solutions has also been investigated.

(2) Studies of lime-penetration and rate of combination with the soil of numerous plots and fields that have received lime dressings during the past three years have been completed.

(3) A phosphate survey of the soils of cane-fields has been continued. Various methods of determining phosphate have been critically examined. The method finally selected for application to cane soils is a colorimetric method recently devised by E. Truog.

(4) The phosphate relations of various soil-types (red soils ; highly humus soils, etc.) are being investigated.

(5) A new base-exchange method, involving leaching with alcoholic solutions of ammonium acetate, is being tested.

(6) The measurement of various constants on soil samples collected from numerous profile-pits excavated in representative soil types within the sugar-cane lands has been completed, and the results charted in colours on profile-cards.

The same department has also supplied the following summary of manurial and liming studies on sugar-cane soils.

(*a*) *Manurial Experiments in Co-operation with Imperial Chemical Industries, Ltd.*—The planting operations in connection with these experiments were completed in October 1930. A report on the experiments, reviewing progress to the end of 1930, was submitted to the Governing Body in January last. Research on the experiments during this year has been confined mainly to the standardisation of the soils of the experimental area, and to the examination of the variation in nitrogen status (ammonium-ion and nitrate-ion), with climatic conditions, of the surface and sub-surface plot soils receiving the following treatments: (*a*) no manurial treatment, (*b*) ammonium sulphate alone, (*c*) ammonium sulphate and ground limestone, (*d*) ammonium sulphate, ground limestone, potassium sulphate and superphosphate.

(*b*) *Manurial Experiments in Co-operation with the Froghopper Investigation Committee.*—(1) *Lime and Pen Manure.*—The two large-scale experiments, set up in 1929, have been reaped successfully for the first time. Experience proves that it is possible accurately to reap very complex experiments of modern type under tropical conditions, provided that adequate precautions are taken. These experiments have afforded definite and useful data as to the effect on quality of juice, the yield of plant canes and sugar per acre, of increasing doses of ground limestone in the presence and absence of pen manure, on: (*a*) thoroughly degenerated alluvial soils of the type believed to be of common occurrence in the tropics, and (*b*) unflocculated and highly unsaturated, but relatively undegenerated, clay soils.

(2) *Ammonium Sulphate.*—The results given by these experiments during the present season are consistent with those obtained in previous years. They show that increments in yield of sugar-cane as large as 80 to 120 per cent. can be obtained by the use of ammonium sulphate under appropriate conditions. In direct consequence of these experiments, there has been a considerable increase in the use of ammonium sulphate in general estate practice during the years 1929–30 and 1930–31, with extremely satisfactory results. It may now fairly be claimed that considerable progress has been made in placing the use of this fertiliser on a satisfactory practical basis in Trinidad.

(3) *Potash and Phosphate.*—Endeavours are being made to determine whether the yield of sugar per acre can be further increased by the application of potash and phosphate in addition to nitrogen. The need for a carefully adjusted ratio of potash to phosphate has already been demonstrated.

(4) *Pen Manure versus Artificials.*—Small experiments are in progress to compare directly the value of pen manure with artificials.

(5) *Filter Press Mud.*—The true value of filter press mud as a manure, under Trinidad conditions, is being investigated.

Palm Sugar

Ceylon.—According to the report of the Chemical Division, Department of Agriculture, for the period January to June 1931, analyses of a large number of samples of the saps (*toddies*) of the kitul (*Caryota urens*) and palmyrah (*Borassus flabellifer*) palms in the Peradeniya and Jaffna districts respectively, were carried out to determine the dietetic value of these toddies. The saps were collected by different methods. The results are summarised in the attached table.

Nature of sample.	Total solids.	Grams in 100 c.c. sap.			
		Cane Sugar.	Reducing Sugars.	Acidity as Acetic Acid.	Alcohol.
	Per cent.				
Kitul toddy (direct from spathe)	—	13·6	Traces	—	—
Palmyrah toddy (direct from spathe)	—	8·1	Traces	—	—
Kitul toddy (sweet; collected in limed pots)	—	12·6	Traces	—	—
Palmyrah toddy (sweet; collected in limed pots)	—	9·1	0·10	—	—
Kitul toddy (collected in smoked pots)	11·6	8·9	1·76	·19	—
Palmyrah toddy (collected in smoked pots)	10·8	8·1	0·98	—	—
Kitul toddy (collected in new pots)	12·8	12·0	0·22	·06	—
Palmyrah toddy (collected in new pots)	10·8	8·6	1·10	·17	—
Kitul toddy (collected in old pots)	1·2	—	0·98	·27	3·32
Palmyrah toddy (collected in old pots)	5·8	1·9	0·46	·40	3·14

The results indicate that kitul toddy has a higher sucrose content than palmyrah toddy. The dietetic value of toddy, apart from its food value as revealed by these analyses, lies in the yeast, which, besides containing enzymes essential for the digestive processes, is an excellent source of vitamin B.

ROOT CROPS

Yams

Gold Coast.—The Department of Agriculture reports that on the Gold Coast the cocoyam has been found to be an admirable temporary shade for young cacao, and at the same time to have value as a good catch crop. Five varieties of cocoyam have been examined and described by J. Wright. Four of these are varieties of *Xanthosoma sagittifolium,* and one a variety of *Colocasia antiquorum.* The descriptions, together with local methods of preparing the roots for food, are given in a paper in the *Year Book* for 1930.

The causal agent of leaf spot disease on *Amankani* varieties of cocoyam has been proved to be the result of attack by the fungus *Phyllosticta colocasiæ.* The spots are zonate and bear numerous black pycnidia of the fungus. In pot experiments the disease has been associated with plants suffering from a deficiency of potash.

Root rot in cocoyams has been studied by J. Wright (vide *Year Book,* 1930). In different countries the disease has been attributed to a variety of organisms, viz. *Vasculomyces xanthosomæ* in association with a species of *Fusarium ; Rhizoctonia* sp. ; *Cladosporium colocasiæ ; Pythium aphanideratum ; Sclerotium Rolfsii ;* and *Bacillus caratovorus.* Of these *Pythium* has resisted all attempts at isolation, and Hartig has shown (*Journ. Agric. Res.,* vi, **15,** 549) that at least *S. Rolfsii* and *B. caratovorus* are merely wound parasites. J. Wright in the course of the paper gives reasons for his opinion that all the organisms, including the species of *Pythium,* are soil saprophytes, and only become capable of attacking the roots when the plant is in a debilitated condition and the roots have already begun to die off. Stated briefly, he is of the opinion that some particular condition of host and environment is necessary for fungal penetration, and suggests that, on the Gold Coast, deficiency of available potash in the soil is the cause.

VEGETABLES

Okra (*Hibiscus esculentus*)

Ceylon.—According to a report of the Mycological Section, Department of Agriculture, for the first half-year 1931, inoculation experiments were carried out on healthy okra (bandakkai) plants, raised from seed in the laboratory compound, to ascertain whether the so-called mosaic disease of bandakkai at Labuduwa is infectious or contagious or both. Five sets of experiments were carried out.

1. Mottled leaves were ground in a mortar with distilled water and the juice extracted was injected with a hypodermic syringe into the leaf stalks and the stems of fifteen plants when they were seven weeks old.
2. Mottled leaves were crushed and placed on both surfaces of healthy leaves of ten plants without wounding.

3. The leaves of ten plants were similarly treated after wounding with needle pricks.

4. Mottled leaves were placed in contact with both surfaces of the leaves of seven plants.

5. Mottled leaves were placed in contact with healthy leaves after the latter had been wounded by scraping with a scalpel.

In every case the results were negative. Failure to obtain positive results by these methods does not imply that the disease is not a virus disease. It has been shown that in certain virus diseases where artificial inoculations were unsuccessful, insects as aphids were able to transfer the disease.

OIL SEEDS

Chaulmoogra Oils

Ceylon.—According to the Report of the Experiment Station, Peradeniya, for the half-year January to June 1931, all the young plants of *Hydnocarpus Wightiana,* the seed of which is one of the sources of Chaulmoogra oil, were so badly and continuously attacked by a caterpillar (*Pronomenta sarcopis*) that they were all replaced by plants of *Taraktogenos Kurzii* ; the latter are doing well and making excellent growth.

Coconuts

Gold Coast.—The Department of Agriculture has furnished the following report on investigations conducted during the period July 1930 to June 1931.

The work on coconuts in progress at Atwabo was outlined in the report for January to June 1930 (this BULLETIN, 1930, **28**, 496). In a paper in the *Year Book,* 1930, further results for the year 1930–31 are given by W. C. Fishlock. The problem of copra storage in the Atwabo District has not proved so difficult as was anticipated. It has been observed that copra readily absorbed moisture from the atmosphere, and the relative humidity was known to be high. In consequence it was feared that, during storage, sufficient water might be taken up to permit growth of moulds to occur. Further observation, however, has shown that while copra does absorb moisture in damp weather, it also parts with it during dry periods, and there is no record of a sample of initially well dried copra taking up sufficient water to enable harmful moulds to grow. It is stated that the grey-green mould (*Penicillium* sp.) mentioned in the previous report, which develops on the outside of a heap of well-dried copra during storage, takes

103 days to develop. Well-dried copra can be stored safely in the district for three months in the wet season, and longer in the dry season.

In 1930–31 the total production of the plantation was 101·15 tons; it is estimated that the plantation when in full bearing will produce 120 tons per annum. The yield per acre for the year is given as 13 cwt. 4 lb. of copra, or 3,738 nuts, and the ratio of dry copra to kernel for the whole crop was 57·6 per cent.

W. C. Fishlock has also designed three types of simple copra driers to meet the needs of small farmers, at a cost within their means (vide *Year Book* 1930). Two of them, type "B" and type "C," are stated to be suitable on all necessary points. Type "B" can deal with the produce of 10 acres of coconuts, and type "C" with that of 50 acres. Both produce good quality copra and are made from materials obtainable locally. The cost of erecting type "C" is given as £40.

In the *Year Book*, 1930, J. Wright has a note on coconut leaf collapse. The symptoms of the affection are a falling forward of the leaves consequent on premature collapse of leaf stocks, and collapse of fruit bunches thus deprived of their support. Leaf collapse occurs during the dry season, and the palms recover to some extent during the subsequent rains. It is suggested that unsuitable water relation is the cause of the trouble, with which no parasites are associated.

Ground-Nuts

Nigeria.—According to the report of the Agricultural Botanist, Northern Provinces, for the half-year ending June 30, 1931, as mentioned in a previous report (this BULLETIN, 1930, **28**, 497), improved strains of ground-nuts have been produced at Zaria and Kano, with satisfactory oil contents. At Zaria three types, yielding 22, 17 and 14 per cent. better than local nuts, are being tested on a larger scale. These are spreading ground-nuts suitable for hand cultivation. At the same time three erect strains suitable for cattle cultivation, which yielded 19, 15 and 11 per cent. better than local nuts, are being tested on a larger scale. At Kano, where owing to the sandy soil a spreading ground-nut can be lifted by cattle, four selected spreading strains, yielding 21, 21, 18 and 14 per cent. better than native, are being tested on a large scale, in addition to Philippine White which gave a 19 per cent. increase on native.

At both stations the large scale yield trials are being replicated in small scale trials in order that the results of the two trials with the previous season's results may justify a commencement of multiplication of the best types in the following season.

At the same time, single plant selections are continuing to be made, although, if the increases mentioned above are maintained, it is not anticipated that further substantial increases in yield will be forthcoming. Further improvement will tend to be in hulling percentage and oil content.

Oil Palm

Nigeria.—The Botanist, Southern Provinces, reports that an analysis of the individual yields of oil palms at Calabar shows that a number of ordinary hard-shelled trees compare very favourably with the Deli type in Sumatra. Certain individual trees of any of the main types, hard, soft, green or mantled, are capable of giving very high yields. The maximum for a plantation appears to take place from 10 to 12 years after planting; this is followed by annual fluctuations without the average over a period falling. The individuals in a plantation show great variations in yield, some are consistently good, others consistently bad, whilst several produce heavy yields which are followed by equally poor ones.

In the oil palm breeding experiments controlled crossing of types has been added to the usual routine of self-fertilising selected trees at Calabar.

The Assistant Director of Agriculture, Southern Provinces, reports that the experimental work on the improvement of native-owned oil palm groves in Owerri and Calabar Provinces has been continued. In addition results are now available from a further experimental plot in Benin Province. The groves are native-owned and harvesting is done by the owner and weighings are made by an officer of the Department. It was found in the course of the year that in one or two cases, owing to incomplete harvesting by the owner or to harvesting in the absence of the Department's officer for which no weighings consequently were recorded, the returns obtained from the groves were incomplete and were therefore not a sufficiently accurate index of the position. The groves concerned were accordingly discarded from the experiment. The returns from these groves, for what they are worth, are just as favourable to the cleared plots as those given below.

Six experiments have been retained out of the original ten, and with the additional one at Benin, the total for

1930 is seven, as compared with six in the preceding years. The data now given for 1928 and 1929 refer only to these six plots and therefore differ slightly from those given in this BULLETIN (1930, **28**, 502).

The mean yields of bunches of fruit for the years 1928, 1929 and 1930 are given below in pounds per acre.

	1928.	1929.	Increase over 1928.	1930.	Increase over 1929.
Mean of " Bush " plots .	1,525	2,033	508	2,063	30
Mean of " Cleared " plots .	2,119	2,989	870	3,323	334
Difference in favour of " Cleared " as compared with " Bush " plots . .	594	956	—	1,260	—

It will be seen that in 1930 the yields of the " Bush " plots are much the same as in 1929, while the " Cleared " plots show approximately a 10 per cent. increase. The advantage of the " Cleared " plots over the " Bush " plots appears to be growing steadily greater from year to year.

FIBRES

Cotton

Gold Coast.—In a report on investigations conducted during the period July 1930 to June 1931, the Department of Agriculture states that the three promising strains of cotton, T66, T57 and D28, isolated in the season 1929–30 at Tamale, have been subjected to small bulk trials. One strain, D28, has maintained its promise, and given an increased yield (181 lb. per acre). The two other strains were disappointing, and further purification is necessary before bulk trials can usefully be attempted.

Of 23 new varieties of cotton tried (11 American, 3 Native and 9 Asiatic) only two Asiatics, Coconadas and Karungani, showed any promise.

Bollworm has again proved to be the major insect pest; 35·8–41·9 per cent. of shed bolls had been attacked by bollworm.

Manurial trials indicated that without treatment to improve organic content of the soil, artificials are of little use. The beneficial effect on cotton of a previous green manure crop was clearly shown in the rotation investigation. Following upon a crop of Bengal Beans which had been dug in, Allen variety yielded an average of 328 lb. per acre. This compares with 157 lb. in the previous season, when no green manuring was practised (vide *Year Book*, 1930).

Cotton trials were continued at Kpeve in 1929–30 and 1930–31. In the season 1929–30 the strain of Ishan (a variety imported from Nigeria several years ago) then possessed by the station, again proved to be in no way superior to the local Sonko variety. It was replaced in 1930–31 by a strain of Improved Ishan, freshly imported from Nigeria. This variety in a five-acre trial with the local Sonko variety gave distinctly promising yields.

Variety.	Yield per acre.
Improved Ishan	498 lb. 14 oz.
Sonko	283 lb. 14 oz.

There were indications that the optimum planting date for these types of cotton was not later than June 3, and that the optimum planting distance was not less than 4 × 4 ft. It was observed that improved Ishan was, at the end of February and regardless of planting date, in a moribund condition and had largely ceased to produce bolls. This is an advantage in a district where stainer attack is considerable (25–37 per cent. of the crop is stained cotton). The enforcing of a close season (March–May) with this variety would be relatively simple. Sonko bolls freely in March and later.

Loggerhead occurred to some extent in cotton on each site on the station occupied by the crop, but whereas the incidence was only 2·1 per cent. on cotton grown on virgin soil, it was recorded as 17·4 per cent. on soil in a very exhausted condition. It was associated with root attack by a beetle, *Syogrus calcaratus*, and in this connection the following table is of interest: data were obtained from an examination of each plant in a one-acre block.

	Number damaged by beetle.	Number undamaged by beetle.	Percentage damaged by beetle.
Apparently healthy plants	41	1,631	2·45
Diseased plants	348	6	98·30

It is suggested, therefore, that the Loggerhead might be caused by a beetle, *Syogrus calcaratus*, which attacks the roots of cotton plants that are in a debilitated condition owing to malnutrition.

Nigeria.—According to the Report of the Botanical Branch, Southern Provinces, for the half-year ended June 30, 1931, an investigation on the behaviour of Ishan cotton when grown through (*a*) Early Maize, (*b*) Late Maize, has given the following results:

Ishan Cotton through Early Maize.—Though the stem height of the cotton is depressed by nearly 30 per cent. in its early stage, recovery is rapid comparatively soon; this occurs at the commencement of the second rains. Neither flower production, boll production, boll shedding nor yield is influenced by the intercropped Early Maize.

Ishan Cotton through Late Maize.—The stem height is not affected, but flower, boll production and yield are reduced by 25 to 30 per cent. Boll shedding is also rather more severe and the delivery of the crop somewhat retarded. It is doubtful if these effects would be so marked on native farms where the spacing is more lenient. There is an indication that the yield of the Late Maize is depressed.

The usual routine for the selection and multiplication of Ishan cotton has been continued, but in view of the market dislike for rough cottons, work is being commenced by Dr. Harland in Trinidad to remove this character from the Ishan plant. At the same time seed of Sea Island and Big Boll Okra has been received from the West Indies for trial. Lint samples of the progeny of the Ishan cross mentioned in the 1930 July report (this BULLETIN, 1930, **28**, 503) have been sent to the Shirley Institute for tests with special reference to roughness.

The Agricultural Botanist, Northern Provinces, reports that Strain D, which was being grown over some 400 acres at Daudawa, having proved to be susceptible to jassid attack, has been discarded.

Two small scale yield trials were conducted, using the Departmental method.

Yield Trial A.—Trial of four Allen selections against commercial Allen as control

Average yield per plot of 41 control plots . . .	328 grs. lint
,, ,, ,, ,, 10 plots L	328 + 18·8 ± 14·3
,, ,, ,, ,, 10 ,, B	328 − 71·1 ± 14·3
,, ,, ,, ,, 10 ,, C	328 − 18·9 ± 14·3
,, ,, ,, ,, 10 ,, Strain 18 . . .	328 − 52·5 ± 14·3

It will be seen that strain L was the only one to equal commercial Allen in yield. As regards value, samples of L, C and control were sent home for valuation, and with the control valued at 6·22*d.*, strain L was valued at 6·67*d.* and strain C at 6·77*d.*, based on April American Futures at 5·42*d.* and Middling American at 5·57*d.*

Yield Trial B.—Trial of one Allen selection and three exotics against commercial Allen

Average yield per plot of 41 controls	333 grs. lint
,, ,, ,, ,, 10 plots strain 1 . . .	333 − 9·3 ± 22·8
,, ,, ,, ,, 10 ,, A12·5 . . .	333 − 11·9 ± 22·8
,, ,, ,, ,, 10 ,, H21·3 . . .	333 − 42·2 ± 22·8
,, ,, ,, ,, 10 ,, U4·5 . . .	333 + 5·5 ± 22·8

It will be seen that with the exception of H21·3 the strains yielded as well as the control. As regards value, all were sent home for brokers' valuation with the following results: Commercial Allen was valued at 6·22*d.*, Strain 1 at 6·22*d.*, Strain H21·3 at 6·32*d.*, Strain A12·5 at 6·02*d.*, and Strain U4·5 at 6·22*d.*, with the same home prices as mentioned above.

In the multiplication trials 20 acres each of H21·3, J, G, U4 (200 lb. from Rhodesia) and D are being grown at the Empire Cotton Growing Corporation's farm at Daudawa in isolated plots. Of these, if H21·3 and U4 are to be continued they will have to show an improvement in yield, which they may do at Daudawa. Strain D is being grown as a control to observe relative jassid infection in J and G, in which, although their quality is better than that of commercial Allen, there is still a doubt as to their degree of jassid resistance. At the same time strains L and C, and a number of other promising strains, are being bulked in isolation plots, pending results of this season's yield trials and brokers' valuations. Further introductions have been made from India, Rhodesia and America and are being grown in observation plots.

Up to the present time there is no improved cotton for the "middle belt," the Ilorin, Kabba, Benue and Niger Provinces. Meko cotton, the native cotton of Ilorin, is a poor cotton and yields badly. The "Munshi" cotton of Benue Province yields rather better and is valued at 25 points "on"; and the native "Kabba" cotton yields well and is valued at 80 points "on." Unfortunately the Kabba cotton is extremely late maturing and is very glabrous. At present, therefore, it appears that the problem is to select in Kabba cotton for early maturity, quality and yield. Single plant selections have been made, and bulk plots established for selection purposes.

RUBBER

Para

Ceylon.—According to the Report of the Experiment Station, Peradeniya, for the half-year January to June 1931, an experiment to determine whether the direction of the slope of the tapping cut (i.e. from left to right or from right to left) would have any influence on yield was started in 1926 and brought to a conclusion at the end of March 1931. One hundred and fourteen trees were used for this experiment, but six which developed brown bast disease in 1929 had to be taken out of the tapping records. The total difference in yield over the whole five-year period was only 2,238 grammes of dry rubber in favour of a left-to-right cut which is the normal estate practice. This difference is too small to be of any significance and it is not considered, therefore, that the direction of the slope of the tapping cut exerts any material difference on the yield.

MINERAL RESOURCES

CYPRUS

The Imperial Institute has received from the Acting Colonial Secretary the following report on the work carried out by the Mines Branch of the Land Registration and Survey Department during the first six months of 1931 :

The continuance of the depression in trade has caused further reduction in the mining activity of the Colony, and the output of minerals (with the exception of gypsum) has shown a big decrease over that of the corresponding period of last year.

Prospecting operations by the larger companies employing drilling methods have been curtailed, although in one case the discovery of a small ore body of pyrites has given distinct encouragement to continue work.

The following statistics refer to the work done at the Skouriotissa pyrites mine of the Cyprus Mines Corporation :

	First 6 months. 1931.	First 6 months. 1930.
Tonnage mined	75,751	139,611
Tonnage exported	79,240	135,237
Underground labour (average per day).	447	805
Total surface and underground labour (average per day)	990	1,665

The following statistics refer to the development at the Mavrovouni pyrites mine of the Cyprus Mines Corporation :

	First 6 months. 1931.	First 6 months. 1930.
Boreholes, footage sunk	382	1,922
Boreholes, labour (average per day) .	20	35
Development, total footage	1,919	4,881
Development, labour (average per day).	73	365
Tonnage mined	9,741	12,290
Tonnage exported	8,021	9,500
Labour, underground only (average per day)	274	639
Total underground and surface labour (average per day)	544	1,036

The following table refers to the work done at the Lymni mine of the Cyprus Sulphur and Copper Co. Ltd. :

	First 6 months. 1931.	First 6 months. 1930.
Underground development footage	56	561
Opencast, overburden removed, cub. yds.	18,736	nil
Tonnage mined	363	nil
Copper precipitate produced, tons	9	nil
Average daily labour	78	50

No development work was done at the Troodos mines of the Cyprus Chrome Company Ltd. during the first six months of 1931, and no mineral mined or exported.

The following statistics refer to the output of the Cyprus Asbestos Co. Ltd., Amiandos :

	First 6 months. 1931.	First 6 months. 1930.
Rock mined, tons	16,118	339,298
Rock treated, tons	2,659	74,081
Finished asbestos produced, tons	15	2,291
Finished asbestos exported, tons	607	3,063
Average daily labour	296	1,131

Minerals exported, other than those dealt with above, were as follows :

	First 6 months. 1931.	First 6 months. 1930.
Terra umbra, tons	1,692	2,751
Terre verte, tons	16	2
Gypsum, tons	6,223	5,477
Building stone, cub. yd.	nil	349

FEDERATED MALAY STATES

The Imperial Institute has received from the Director of the Geological Survey the following information relating to the work carried out during the half-year ended June 30, 1931.

Mr. J. B. Scrivenor, I.S.O., who had been in charge of the Federated Malay States Geological Survey for twenty-eight years, proceeded on leave to England on May 30, 1931, prior to retirement.

Mr. E. S. Willbourn, Senior Geologist, has been appointed to act as Director.

Mr. Willbourn examined a number of tin mines, and in two of them found new occurrences of tourmaline-corundum rock in situ. The Beatrice Mine was closed down without any sustained effort having been made to find the root of the pipe in granite, and the attempt is now, doubtless, postponed until the price of tin is higher. Interesting developments at the Scheelite Mine, Kramat Pulai, were followed, and a visit of inspection was made to the coal mines owned by Malayan Collieries Ltd. A new departure in Malaya was a successful aeroplane-trip to complete the mapping of the long quartz-reef which passes into rugged mountainous country north-east of Kuala Lumpur.

Dr. Ingham, Mining Geologist, Federated Malay States, continued his recording of evidence from mines, and Mr. Savage made a useful start with the mapping of the Sungei Siput District on topo sheets, scale 1 in. = 1 mile.

Mr. Shenton, Chemist, besides doing his usual routine-work of assays and other analyses, gave advice on the settling of slimes in a mine where great trouble was being experienced. He also conducted experiments in connection with the economic possibility of replacing Chinese manual methods of concentrating low-grade ore by mechanical means.

GOLD COAST

The Imperial Institute has received from the Director of the Gold Coast Geological Survey a report on the Research Work carried out during the year ended June 30, 1931, of which the following is an abstract :

Manganese.—The detailed examination of the Nsuta manganese deposits, Tarkwa District, begun in 1929 by Mr. O. A. L. Whitelaw, is now completed, the results of which it is hoped will soon be published.

The question of the origin of these manganese ores is of considerable economic importance. The Director examined the deposits, and believes that they represent (Pre-Cambrian ?) deposits of high-grade manganese ores which in general have not been modified greatly by vadose waters in recent geological times, and that where the structural features are favourable, the ores are likely to persist in depth. A section through one of the hills at Nsuta shows a capping, averaging from 30 to 35 ft. in thickness, of secondary " detrital " ore containing about 40 per cent. manganese, resting on large lenticular black ore-bodies, which usually contain from 50 to 55 per cent. manganese, and the surrounding country rocks which are decayed volcanic rocks, ashes and phyllites.

The black ore-bodies are traversed by numerous veins of highly sheared milk-white quartz, identical in appearance with the ancient (Pre-Cambrian ?) sheared quartz veins in the surrounding Birrimian rocks. If these quartz veins are of ancient origin, then the deposits of high-grade ore must have been formed at an earlier date.

Gold.—The north-eastern extension of the banket and associated beds of the Tarkwa goldfield was mapped from the Adja Bippo mine, near Abosso, to Damang, on the Central Province Railway. Many old adits along this line were examined and sectioned.

Attention will probably again be turned to the considerable possibilities of the Tarkwa goldfield, and particularly to the deeper ground to the north-west of the main workings between Tarkwa and Cinnamon Bippo. There is undoubtedly a very large area underlain by the banket at a depth of less than 3,000 to 4,000 ft. from the surface. The deepest mine workings, which are less than 2,000 ft. vertically from the surface, show little if any decrease in the gold values in depth, and it should be possible from the pitch of the payable shoots of ore in the developed mines to indicate in a general way favourable localities for deeper development.

Good prospects of gold were found in the Shushang Su, Kibi District, and alluvial gold was found to occur extensively in the gravels of the large streams traversing the wide phyllite area between the Tano and Ankobra rivers, north of the Insu-Enchi motor road. These gravels have been mostly derived from quartz-reefs.

The lower levels of the Obuasi (Ashanti Goldfields Corporation) mine were examined, and it is hoped that a report on the Obuasi auriferous area will be ready for publication by the end of 1931.

At the request of the Akoon Syndicate Ltd., Mr. Whitelaw examined the lower levels of the Abbontiakoon mine, and visited the old Kotra Verchy mine, now being prospected by the same Syndicate.

Diamonds.—The Director, Dr. Cooper and Mr. McGregor made a detailed examination of the Birim diamond fields. No indications were found of the existence of kimberlite pipes, pegmatites, true conglomerates, or old marine gravels, from which the diamonds could have been derived.

The diamonds are believed by the Director of the Geological Survey to be of local origin, and to have come from the belts of metamorphosed basic and ultrabasic igneous rocks, with inclusions of phyllites, of Birimian age.

The following evidence supports this view : (*a*) Streams crossing rocks which are essentially grey and black phyllites, contain appreciable quantities of gold, but appear to be practically free of diamonds. (*b*) The richest concentrations of diamonds occur in zones parallel to the strike of the rocks which in the central zone are essentially metamorphosed basic and ultrabasic igneous and fragmental diamonds. All the streams in this zone carry diamonds. (*c*) The diamond-bearing gravels in the smaller streams are composed almost entirely of sharply angular quartz, and the associated heavy minerals are likewise angular ;

both have been derived from the local rocks, and, although the diamonds vary greatly in size from stream to stream, they are rarely graded according to size and show little or no sign of wear. (*d*) In a certain stream six diamonds with a mineral encrustation were found. These were submitted to Dr. A. Brammall for examination, who reports that the encrustation is essentially a lime silicate, probably wollastonite. This indicates that the diamonds have not travelled far, otherwise the wollastonite would have become detached, or at least rounded. (*e*) Diamonds have been found in some of the hill deposits of the area, but outside the area they are barren. (*f*) Diamonds are not found in streams the drainage of which is wholly in granite rocks.

Mr. Whitelaw and Mr. Lunn found sporadic diamonds in the district south-west of Tarkwa, but the results were not encouraging, although the rocks of this area are on a somewhat similar geological horizon to those in the Birim river district.

Chromite.—Further investigations were made in the serpentine area south of Anum (Volta river district).

Two samples of the chromite analysed by the Imperial Institute contained 2·95 and 7·6 per cent. silica, 26·15 and 25·21 per cent. alumina, and 37·60 and 27·48 per cent. chromic oxide respectively.

The serpentine area containing thin seams of chrysotile asbestos was briefly examined.

Masses of serpentine were located near the Bonsa River, south of Prestea, and small loose lumps of chromite were found nearby. The work in this locality will be resumed in the forthcoming field season.

Water Supply.—Some work was done in connection with the water supply of the towns Koforidua, Kumasi, Tamale, Adukrom and Asesieso, and of the towns situated along the foot of the south-east flank of the Akwapim range, where there is great scarcity during the dry season.

The excavations for dam-sites at Kumasi and Tamale were examined and reported upon by Dr. Cooper.

At Koforidua, a reservoir site was found by Mr. McGregor superior to that originally proposed.

NIGERIA

The Imperial Institute has received from the Director of the Geological Survey the following half-yearly summary of the current geological work in Nigeria.

Gold.—At the beginning of the season the mining areas of Beni and Kasai were visited. There had been a revival of activity in mining in these areas towards the close of 1930 owing to a find of a 14-oz. nugget. Nearly all the areas taken up were in localities which had been mined for gold previously, and after a short period of activity interest gradually waned. A feature of the field is the coarseness of the gold, and in spite of the fact that it is clearly of local origin, it has not yet been found in situ.

The remainder of the season was spent in examining the Kushaka and Kwiambana standard sheets, which cover an area of approximately 2,500 square miles. The geology of these sheets is very similar to that of the adjoining sheets which have been described in earlier reports. Over a considerable portion of this area, however, the ancient schists and gneisses are obscured by sheets of the Eocene Nupe sandstone which, at its base, is auriferous. A further source of gold has been proved in the terraces which line many of the rivers of the area, particularly the Upper Koriga and Karara.

Water.—During the past half-year, the activities of the Department have been directed chiefly to water supply problems and the sinking of wells in Sokoto, Bornu and Hadejia Emirates. The results obtained in each case have been very encouraging.

The re-sinking of the Deep Shaft in Sokoto town was commenced in early January. It was decided to open this shaft out so that it will have a finished diameter of 9½ ft. in the hope that considerable quantities of water will be obtained. At the end of June the shaft was down to the 100 ft. level and should reach water about the end of August, when exhaustive pumping tests will be conducted. The experimental well at Denge reached water at 182 ft., but the yield from the aquifer, which is perched, is disappointing. Further developments are now in progress. In the bush areas sinking is proceeding steadily and a number of wells are now being put down along the main Sokoto-Gusau road. During the period under review eight new wells were brought into production.

The engineers appointed to the Hadejia and Bornu Emirates arrived in Nigeria at the end of January, and as all the necessary equipment was already on the sites, sinking was commenced on February 1. The foreman arrived in April. In the Hadejia Emirate, operations were commenced at Mallam Maduri station and then extended towards and to Hadejia. By the middle of March nine wells were in the process of sinking, all of which were completed by June. No great difficulties were met with in this area, and in most cases it was found possible to sink to water level before lining was necessary. In some cases, however, loose grits just above the water table caused trouble and delay. Nine wells were sunk to water during the period under review and operations have now been transferred to Garin Gabbas and Birniwa.

In Bornu Emirate operations were commenced at Nguru, the railhead of this branch of the railway, and later extended to the north-west to Gumsi and Machena. In the Nguru area, few difficulties were encountered and five wells, all of which are giving good yields of water, were put in. The depths are about 50 ft. Towards Nguru the wells are deeper and the ground becomes more difficult. In most cases simultaneous sinking and lining were necessary owing to the presence of loose unconsolidated sands. In some wells after passing through loose sands the ground became very hard. At the end of June, twelve producing wells had been completed in this Emirate and a number of others are now in the course of construction. In the earlier part of the year, investigations were commenced in Central Bornu, to which area well sinking will be extended later. These investigations have disclosed the fact that there is a sub-artesian basin in the Gubio district and the evidence so far obtained points to the possibility of artesian water being found at greater depths.

SOUTHERN RHODESIA

The Imperial Institute has received from the Director of the Geological Survey of Southern Rhodesia the following notes on the work recently carried out.

Gold.—Owing largely to the depressed state of the metal markets, renewed interest is being taken by prospectors and mining men in the gold lodes of Southern Rhodesia. Since the date of the last report a large number of properties has been examined by the Geological Survey and some of the larger and better known ones have been examined in detail.

The investigation of the geology of the *Gaika* gold mine, situated near Que Que, has been completed by Mr. S. C. Morgan, who showed that the chief events leading up to the formation of the auriferous ore were the following :

1. The deposition of sediments (sand, pebbles and mud), and the extrusion of basic lavas.
2. Intrusion of peridotites.
3. Folding of sediments, lavas and peridotites into asymmetric folds along roughly north-east to south-west axes.
4. Injection of basic dykes (diabase).

5. Commencement of granite intrusion.

6. Tilting of asymmetric folds to the north-east by western tongue of granite, and commencement of serpentinisation of peridotite.

7. Contraction of cooling granite and the formation of fissures along and parallel to the plane of contact.

8. Injection of porphyrite accompanied by carbon dioxide along fissures.

9. Complete serpentinisation of the peridotite followed by carbonation to talc-carbonate-rock and to quartz-magnesite-rock (earlier silicification) through the agency of carbon dioxide.

10. Re-opening of fissures and introduction of barren quartz, forming the main and branching reefs.

11. The injection of two " buck " reefs, one of which displaces the main reef.

12. A later re-opening of the fissures and introduction of the gold-bearing solution, forming the various ore bodies.

An investigation of the *Phœnix* lode of the Globe and Phœnix mine, a near neighbour of the Gaika mine, was continued by Mr. A. M. Macgregor. The mine is the richest gold lode in Rhodesia and one of the richest in the world. The ore body consists of branching antimonial quartz lodes in fault fissures intersecting the intrusive contact of a gneissic granite batholith with talc-magnesite rock, the latter being one phase of a body of ultrabasic rock. Its geological history is very complicated. Between the time of consolidation of the gneissic granite and the incoming of the gold, five periods of dyke intrusion and three periods of formations of quartz or calcite veins have been recognised so far. Some of these veins carry galena and zinc blende, others chalcopyrite. Although they are almost certainly of Archæan age very little disturbance has occurred since their formation.

The examination of the *Shamva* mine was completed by Mr. Tyndale-Biscoe. The ore bodies are probably of a unique type. They are low-grade, the average recovery during the whole time of working having been under 3 dwt. per ton, the extraction about 90 per cent. The mine is situated in an isolated hill rising to a height of nearly 1,000 ft. above the surrounding plain, formed of an arkose of Archæan age intruded by basic dykes of at least two ages. The pay shoots, which are indistinguishable by eye from country rock and therefore only definable by sampling and assay, are from 100 to 250 ft. across in their widest parts, of lenticular shape, and located within definite ore channels. The margins of these ore channels are slightly silicified as compared with the normal rock. In places the pay shoots are characterised by a network of calcite veinlets, but coarse calcite veins, which cut the ore channels and contain much pyrite, are barren and were introduced later than the calcite associated with the gold.

The ore is therefore of the impregnation type formed by the deposition of gold from solution permeating the country rock within the zones which formed the ore channels. Just why these particular zones were picked out by the ascending solutions is not clear, for their petrographic characters are not obviously different from those of the clean country rock. Nor does there appear to be any relation between the ore channels and the geological structure of the hill or any definite horizon in the arkose.

The lode of the *Antelope* gold mine, the examination of which is being conducted by Mr. A. E. Phaup, presents peculiar features. Although the Antelope and Gaika lodes are each due essentially to the invasion of a body of serpentinous rock by quartz and sulphides, they differ considerably. Like that of the Gaika lode the mineral composition of the Antelope lode changes from place to place, but in the latter the metallic minerals pyrrhotine, pyrites, magnetite and specular iron ore usually make up over half the rock. The rest is quartz and the silicates hornblende, actinolite and garnet derived from the original serpentine. Pyrrhotine comprises from 3 to 41 per cent. of the ore. Its presence in such quantity has provided a difficult extraction problem. Formerly the whole of the ore was roasted before it was cyanided, but at present it undergoes mechanical concentration followed by amalgamation. To improve the extraction a special process, by which the pyrrhotine is rendered inactive before cyanidation, has been devised by Mr. R. de Beer, formerly Government Metallurgist. It was successful both in the experimental and in the pilot plant stages, and a plant is now being erected to carry out the process.

In addition to the " Main Reef " at least three smaller parallel lodes are known. These lie within the serpentine country. Outside it only small and apparently shallow quartz veins occur. The mass of serpentine is about five miles long and two to three hundred feet wide. To the north, in the direction of the dip of the lode and of the country generally, is a belt of lavas metamorphosed to amphibolite, hornblendic greenstone and epidiorite about a mile in width and bounded by gneissic granite which exhibits characters closely resembling those of the migmatites described by Sederholm. To the south lie quartzites and arkoses of sedimentary origin invaded by a quartz-diorite batholith after the period of mineralisation.

Pegmatite dykes from the quartz-diorite magma cut the lodes along fault lines and are well exposed in the mine.

A reconnaissance of the Fort Victoria "Blanket" Area by Mr. J. C. Ferguson proved that it was underlain by metamorphosed and steeply dipping quartzites and felspathic grits with slate partings and beds of conglomerate. The last are known locally as "banket" though only rarely is there a close resemblance to the banket of the Witwatersrand. The hard quartzose matrix separating the pebbles is pyritised in the unoxidised rock, and this mineral is often present in the wall rocks of quartzite. The depth of oxidation is as little as 2 ft. in some places, but in others is over 100 ft. A number of claims have been pegged and the conglomerates opened up on what appear to be three separate lines. Gold has been found in both the oxidised and unoxidised conglomerates, but in general the values are very low, and it cannot be said that any body of pay rock has yet been developed.

Mica.—A new field of muscovite mica situated near Rusambo in the Darwin district, 150 miles east of the Miami field, commenced production. The mica occurs in several large pegmatite dykes intruded into a body of soft micaceous schists. The occurrence is thus similar to that of the Miami field, and the trimmed mica sheets of excellent quality have been marketed.

Mineral Springs.—The collection of data regarding the mineral and thermal springs of the Colony was continued. A number of springs have been examined, samples of the water taken and analysed. The samples analysed to date are fairly evenly divided between chloride, carbonate and sulphate waters. The springs are distributed in two main groups in areas marked by faulting of post-Karroo date and by occasional earthquakes at the present time.

Wankie Coalfield.—A collection of fossil plants from the Wankie Coalfield (latitude 18½ degrees south) was described by Dr. John Walton and found to be of exceptional interest in that northern hemisphere plants were found to be mixed with those belonging to the glossopteris flora. The weight of fossil-plant evidence is in favour of regarding the Upper Wankie Sandstones lying above the main coal horizon as being of Lower Permian age or older.

Victoria Falls.—The geological mapping of the country around the Victoria Falls proved that the cutting of the gorge was initiated at least as far back as the beginning of Pleistocene times as shown by the distribution of early palæolithic bouchers, and not about 500 years ago as suggested by the late Professor Schwarz.

The suite of five analyses of plateau basalts from the gorge below the Victoria Falls shows that the basalts have the composition of normal plateau basalts.

Soils.—Analyses of the different horizons in eleven profiles of common types of soil were carried out with a view to determining the processes of weathering and soil formation.

Makarikari Salt Pan.—Mr. A. M. Macgregor accompanied, as geologist, an expedition which explored round the Great Makarikari salt pan in the Bechuanaland Protectorate. The pan occupies the lowest part of a basin of interior drainage and extends for 110 miles from east to west and 60 miles from north to south. Kalahari beds of Quaternary and probably Tertiary age form the northern, western and south-western parts of the area, but in the eastern and south-eastern portions a basalt-capped escarpment of Karroo sediments 400 ft. in height overlooks the pan.

UGANDA

The Imperial Institute has received from the Acting Director of the Geological Survey the following report on the work carried out during the first six months of 1931.

Field Work.—The geological survey of parts of the districts of Bugishu, Budama and Bugwere, in the Eastern Province, begun by Dr. Davies during the first half of last year, was completed ; a large number of specimens were collected and are being worked out, the lavas by Dr. N. L. Bowen of the Geophysical Laboratory of the Carnegie Institute of Washington, the fossils by Dr. Ralph Chaney of the State University of California, and the other specimens by the staff of this survey, with a view to early publication. Maps and sections of the area surveyed were prepared and await printing. The economic interest of the district is mainly the occurrence of workable limestone.

The conditions of salt deposition in lakes Katwe and Kasenyi were again enquired into by the Director in January and the conditions under which No. 1 salt—i.e. the salt of the finest quality, is deposited were observed. Reports on the investigation were submitted to the Imperial Institute.

Other field work comprised a preliminary reconnaissance of parts of the Eastern and Northern Province, including a part of the district of West Nile and West Madi. Some asbestos occurrences were studied.

The geological survey of the Rakai-Kamukalo area in Koki with special reference to the existence of certain bare hollows was continued by Mr. Simmons. One of these bare patches was described in 1919 (Ann. Report, G.S.

Uganda, March 1920), and since then two other similar occurrences have been found. They are very striking, as they occur in the midst of luxurious tropical swamp and forest vegetation, and consist of flat bare areas of stiff clay covered with a thin layer of black peaty silt with no vegetation, and vary from half an acre to almost three acres in extent. These flats are waterlogged, and the water, which is acid with organic acids and contains calcium and magnesium sulphates in solution, generally lies close to the surface. Boring with a hand rig failed to bottom stiff wet clay at 16 ft. in the largest hollow. The Karagwe-Ankolean shales in this part of Koki show numerous quartz veins and stringers, and also veins and impregnations of hydrated iron ores, as well as quartz iron-ore gossans, and in places the shales contain cubical pseudomorphs in limonite after pyrites, so that the suggestion was made that the killing of the vegetation in the bare hollows and its inability to re-establish itself is due to the release of sulphates formed by the decomposition of iron pyrites, and it is hoped to do further boring work to try to locate the sulphide veins and to see if any payable economic minerals occur near or below the flats.

Owing to the economic depression many mining companies have curtailed their activities, with the result that private prospecting has not been so active as it was in the past. Tin ore continues to be mined at Mwirasando and Kikagati, while the copper deposits at Kilembe are still being actively prospected.

Geological advice was given to the water-boring section of the P.W.D., in connection with the boring operations being carried out in Usuku in the Soroti district.

The work in the Seismological Observatory has been continued with both instruments registering. A wireless receiving set has been installed in the Observatory for receiving time signals.

The following publication was issued:

Annual Report of the Geological Survey for the Year 1930.

The following maps were published:

Geological sketch map of the Bukoba Province, Tanganyika Territory.

Geological map of part of Bunyoro.

Laboratory Work.—In the laboratory the usual testing work has been carried out by Dr. Groves on rocks and minerals for officers of the Department and members of the public. This work has included the examination of a number of auriferous concentrates, as well as fire assays for gold and silver, in connection with the recent discoveries of gold in the Kigezi District.

Two chemical analyses were made of the limestone discovered last year by Dr. Davies at Bukusu hill, near Butiru, Eastern Province. One analysis was of a composite sample including all varieties in order to obtain an approximation to an average result for the whole mass. This gave 59·6 per cent. of calcium carbonate and 21 per cent. of residue insoluble in dilute acid. The second analysis was of material of an average good quality which could be maintained in quantity by judicious quarrying operations. This gave the following result :

	Per cent.
Matter soluble in dilute HCl :	
$CaCO_3$	82·7
$(Fe,Al)_2O_3$	5·5
Matter insoluble in dilute HCl:	
Iron ores and quartz	10·2
Undetermined (magnesia below 1 per cent., moisture, alkalis and a trace of phosphate)	1·6

The heavy mineral assemblages of some further granites and sandstones have been examined. The Mityana and Butologo Sandstones, which are considered to be the equivalents of the Bukoba Sandstone to the south, have been found to contain a different assemblage from that of the Bukoba Sandstone. The yields of heavy minerals in the Mityana and Butologo Sandstones are smaller and the range of minerals is very restricted, the bulk of the material being apparently derived from earlier sediments.

This is very different from the Bukoba Sandstone, which is characterised by a large quantity of freshly derived material, the source of which has been shown to be the Newer Granites. While these differences may not necessarily mean marked difference of age, they show that the basin of deposition and the source of the material of the Mityana and Butologo Sandstones were different from those of the Bukoba Sandstones. Lithologically and in thin section the Mityana and Butologo Sandstones are very similar to the Bukoba Sandstone.

Dr. Groves' petrological work has been mainly concentrated on the examination of rocks of the Charnockite Series. A number of occurrences of these were already known in the Protectorate, and search through the extensive collection of slides now accumulated has revealed the presence of a widespread series of rocks representing practically all the types described from India. About a hundred specimens have been examined in detail and micrometric and chemical analyses of these rocks are being carried out. As in India, some of these occurrences are associated with magmatic iron-ores as well as graphite.

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Annual Report of the Veterinary Department, Northern Provinces, Nigeria, for the Year 1929. Pp. 84, 13¼ × 8. (Lagos: C.M.S. Bookshop.) Price 5*s*. 6*d*.

Economic Factors Affecting the Beef-Cattle Industry of Virginia. By C. A. Burmeister, H. M. Conway and A. P. Brodell. *Tech. Bull. No.* 237, *U.S. Dept. Agric.* Pp. 65, 9¼ × 5¾. (Washington, D.C.: U.S. Government Printing Office, 1931.) Price 10 cents.

Bee-Keeping. *Bull. No.* 9, *Min. Agric. and Fisheries.* Pp. 55, 9¾ × 6¼. (London: Ministry of Agriculture and Fisheries, 1930.) Price 9*d*.

Report on the Marketing of Honey and Beeswax in England and Wales. *Econ. Series No.* 28, *Min. Agric. and Fisheries.* Pp. 92, 9 × 6. (London: H.M. Stationery Office, 1931.) Price 6*d*.

Administration Report of the Madras Fisheries Department for the Year 1929–30. By B. Sundara Raj. Pp. 104, 9¾ × 6. (Madras: Superintendent, Government Press, 1931.) Price 14 annas.

Report of the Department of Fisheries, Punjab, for the Year June 1, 1929, to May 31, 1930. Pp. 22, 9¾ × 6½. (Lahore: Superintendent, Government Printing, 1930.) Price Re. 0–12–0 or 1*s*.

FORESTRY

General

Report of the Forestry Commission, New South Wales, for the Year Ended December 31, 1930. Pp. 17, 13¼ × 8¼. (Sydney: Government Printer, 1931.) Price 1*s*. 3*d*.

Annual Report of the Woods and Forest Department, South

Australia, for the Year Ended June 30, 1930. Pp. 13, 13¼ × 8½. (Adelaide : Government Printer, 1931.)

Progress Report of Forest Research Work in India for the Year 1929–30. Pp. 219, 9½ × 6½. (Calcutta : Government of India Central Publication Branch, 1931.) Price Rs. 4–6 or 7*s*. 3*d*.

Progress Report of Forest Administration in the Province of Assam for the Year 1929–30. Pp. 75, 13¼ × 8½. (Shillong : Assam Government Press, 1930.) Price 3*s*. 3*d*.

Annual Forest Administration Report of the Bombay Presidency, including Sind, for the Year 1929–30. Part I. Pp. 72, 9¾ × 6. (Bombay : Government Central Press, 1931.) Price Annas 6 or 8*d*.

Administration Report on the Forest Department of the Central Provinces for the Year Ending March 31, 1930. Pp. 35, 9¾ × 6½. (Nagpur : Government Press, 1931.)

Progress Report on Forest Administration, His Highness' Government, Jammu and Kashmir, for the Year Ending October 16, 1929. Pp. 75, 9½ × 6½. (Jammu : Ranbir Government Press, 1930.)

Administration Report of the Forest Department, Madras, for the Year Ending March 31, 1930. Vol. I. Pp. 235, 9¾ × 6¼. Price Rs. 2–8–0. Vol. II. Pp. 320, 9¾ × 6¼. Price Rs. 2–4–0. (Madras : Superintendent Government Press, 1931.) Volume I is a report on the various activities of the Department in general, while Volume II contains the individual reports of the officers in charge of each district.

Annual Report of the Forestry Department, Nyasaland, for the Year Ended December 31, 1930. Pp. 15, 13¼ × 8¼. (Zomba : Government Printer, 1931.)

Administration Report of the Conservator of Forests, Trinidad and Tobago, for the Year 1930. Pp. 22, 13½ × 8½. (Port-of-Spain : Government Printer, 1931.) Price 1*s*.

Annual Report of the Forest Department, Uganda Protectorate, for the Year Ended December 31, 1930. Pp. 27, 13¼ × 8½. (Entebbe : Government Printer, 1931.) Price Shs. 2.

Annual Report of the Department of Forestry, Union of South Africa, for the Year Ended March 31, 1930. Pp. 34, 13 × 8¼. (Pretoria : Government Printer, 1931.) Price 2*s*.

Forest Gardens. By J. Macdonald. *Bull. No.* 12, *Forestry Commission*. Pp. 116, 9¾ × 6. (London : H.M. Stationery Office, 1931.) Price 2*s*. 6*d*. Description of five forest gardens in the United Kingdom, their layout and species of trees planted.

Les Eucalyptus comme Arbres de Reboisement pour les Pays Tropicaux et Sub-tropicaux. By E. Navarro de Andrade. *Rev. Bot. Appl. et d'Agric. Trop.* (1931, **11**, 416–423). Mainly lists of different types of Eucalyptus.

The Dutch Elm Disease. By C. May and G. F. Gravatt. *Circ. No.* 170, *U.S. Dept. Agric.* Pp. 10, 9 × 6. (Washington, D.C. : U.S. Government Printing Office, 1931.) Price 5 cents. An account of this disease caused by the fungus *Graphium ulmi*.

Cork : from Forest to Pharmacy. A Short Account of the Nature and Manufacture of a Useful Commodity. *Chem. and Drug.* (1931, **115**, 18–20).

Timbers

Report of the Empire Timbers Committee, Forest Products Research Board Department of Scientific and Industrial Research for the Year 1930. *Paper No. E.T.* 23. Pp. 35, 9½ × 7½. (Princes Risborough, Bucks : Forest Products Research Laboratory, 1931.) Mimeographed copy.

First Report of Standing Timber Committee, Colony and Protectorate of Kenya. Pp. 6, 9¾ × 6¼. (Nairobi: Government Printer, 1931.) Price 50 cents.

Notes on Some of the Indian Markets for Madras Timbers. By J. A. Master. Pp. 93, 13¼ × 8¼. (Madras: Superintendent, Government Press, 1930.) This report deals in two parts with the timber market conditions of various markets on the West Coast and internal markets of the Madras Presidency. There are four appendices dealing with buying and selling rates of various markets, selling rates of logs at Government depots, export and import trade of timber of various markets with Malabar and Cochin and names and addresses of important timber merchants.

British Columbia Douglas Fir. Pp. 20. British Columbia Western Red Cedar. Pp. 16. British Columbia Western Hemlock. Pp. 20. British Columbia Spruce. Pp. 16. A Series of Bulletins issued by the Forest Branch, Department of Lands, British Columbia. Size 11 × 8½. (Victoria, B.C.: Chief Forester, Forest Branch, 1930.) Well illustrated bulletins giving a description of the woods and their uses for numerous purposes.

Les Entandrophragma de la Côte d'Ivoire. By A. Aubréville. *Actes et Comptes Rendus de l'Assoc. Col. Sci.* (1931, **1**, 121–129). A description of four species and means of distinguishing them.

The Common Oaks and Chestnuts of Maymyo and Kaland. By C. W. Scott and C. E. Parkinson. *Burma For. Bull. No.* 19. Pp. 18 + 28 Plates, 9½ × 6¼. (Rangoon: Superintendent, Government Printing and Stationery, 1931.) Price Rs. 2 or 3*s*. Brief account of some sixteen species and their distribution.

American Pitch Pine and Its Uses. *Bull. No.* 119, *Trade Promotion Series, U.S. Dept. Commerce.* Pp. 53, 9¼ × 6. (Washington, D.C.: U.S. Government Printing Office, 1931.) Price 10 cents.

Le Bois du Pin Sylvestre en France. By M. Monnin. *Rev. Bot. Appl. et d'Agric. Trop.* (1931, **11**, 321–329). Study of the wood, its properties and uses.

West African Avodiré (*Turraeanthus africana*). By S. J. Record. *Trop. Woods* (1931, No. 26, 1–9). A study of the wood, its occurrence, structure, properties and use.

Aircraft Woods: Their Properties, Selection and Characteristics. By L. J. Markwardt. *Report No.* 354, *U.S. Advisory Committee for Aeronautics.* Pp. 34, 11¼ × 9¼. (Washington, D.C.: U.S. Government Printing Office, 1930.) Price 20 cents.

Sawmill Waste and Its Utilization in British Columbia. By J. H. Jenkins. *Bull.* 83, *Forest Service, Dept. Inter., Canada.* Pp. 56, 10 × 6½. (Ottawa: King's Printer, 1931.)

The Growth and Structure of Wood. *Trade Circ. No.* 3, *Counc. Sci. Indust. Res., Australia.* Pp. 15, 9½ × 6. (Melbourne: Government Printer, 1931.)

Antiseptic Treatment of *Pinus longifolia* (chir) for Railway Sleepers. By S. Kamesam. *Technical Paper No.* 271, *Railway Board, India.* Pp. 31, 9¾ × 6¼. (Calcutta: Government of India Central Publication Branch, 1930.) Price Rs. 2 or 3*s*. 6*d*.

Laboratory Tests on the Durability of Philippine Woods against Fungi. By O. A. Reinking and C. J. Humphrey. *Philippine Journ. Sci.* (1931, **45**, 77–89).

Studies in the Painting of Wood. Influence of Wood Structure on Paint Behaviour. By J. H. Haslam and S. Wertham. *Indust. and Eng. Chem.* (1931, **23**, 226–233).

Gums and Resins

Method for Identification of the Common Gums. By M. B. Jacobs and L. Jaffe. *Indust. Eng. Chem., Analytical* (1931, **3**, 210–212).

Grass Tree Resin. By A. R. Penfold. *Bull. No.* 16, *Technological Museum, Sydney.* Pp. 20, 8½ × 5½. (Sydney: Technological Museum, 1931.) Price *6d.* An account of the gum from the trees of the species *Xanthorrhea,* its collection, and industrial applications.

La Gomme Fossile de Kaori en Nouvelle-Zélande. By P. A. Serre. *Agron. Col.* (1931, **20**, No. 161, 133–137; No. 162, 168–180). An account of the Kauri gum industry and trade in New Zealand.

Reports of the Committee of the Indian Lac Association and of the Director, Indian Lac Research Institute, Namkum, Ranchi, for the Year April 1, 1930, to March 31, 1931. Pp. 53, 9½ × 6¼. (Calcutta: Star Printing Works, 1931.)

Pine Tree Treasures. By N. Owen. *Misc. Pub. No.* 106, *U.S. Dept. Agric.* Pp. 14, 9 × 5¾. (Washington, D.C.: U.S. Government Printing Office, 1931.) Price 5 cents. An account of the collection of pine-tree resin.

Tanning Materials

La Caracterisation Chimico-Technique de L'Ecorce d'Epicea Commun de Roumanie Comme Matière Tannante. By I. C. Otin and G. Huidovici. *Journ. Inter. Soc. Leather Trades Chemists* (1931, **15**, 264–273). An account of the bark from spruce (*Picea excelsa*) known in Roumania as "Molift" and second in importance to oak as a tanning material in that country.

Fiches Documentaires sur les Tanins de la France d'Outre Mer. *Actes et Comptes Rendus de l'Assoc. Col. Sci.* (1931, **7**, 129–138). An account of the following French colonial tanning materials and their cultivation, production and uses: wattle, mangrove, *Acacia arabica* and "Takaout," galls formed on the tree *Tamarix articulata.*

NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

AUSTRALIA AND NEW ZEALAND, WITH PACIFIC ISLANDS AND ANTARCTICA. By L. S. Suggate, B.Sc. Pp. 440, 7¾ × 5. (London: George G. Harrap & Co., Ltd., 1931.) Price *6s.*

This work has been issued as a volume of Harrap's New Geographical Series, of which Dr. R. N. Rudmose Brown is General Editor. A volume on *Africa* by the same author has already been referred to in this BULLETIN (1929, **27**, 425).

Whilst intended primarily for advanced students of geography, the book should find many other interested readers, who will appreciate its clear and practical arrangement and the large amount of information which the author has compressed into a relatively small compass. The remark made in the notice of Mr. Suggate's previous volume regarding the absence of a general map applies equally in the present case; in any future edition there might usefully be included fair-sized folding maps of New Zealand and of the Continent of Australia, if not of the individual States.

MANITOBA: ITS RESOURCES AND DEVELOPMENT. By F. H. Kitto, F.R.G.S. Pp. 191, 9 × 6. (Ottawa, Canada: National Development Bureau, Department of the Interior, 1931.)

The development and present condition of Manitoba, which celebrated its "diamond jubilee" in July 1930, are well dealt with in this concise illustrated handbook. Sections are devoted to the history, natural resources, agriculture, industries, topography, transport facilities, and other features of the province, and the book should be of much interest and utility as a source of practical information.

THE JOURNAL OF THE SOUTH-EASTERN AGRICULTURAL COLLEGE, No. 28, 1931. Edited for the College by S. Graham Brade-Birks, M.Sc. (Manc.), D.Sc. (Lond.), F.Z.S. Pp. 310, 10½ × 7¼. (Wye, Kent: 1931.) Price 8*s.* 6*d.* (post free); to residents in Kent, Surrey and Sussex, 4*s.* 6*d.* (post free).

This well printed and well illustrated part of the annual series of scientific proceedings of the South-Eastern Agricultural College (University of London), Wye, Kent, reflects the great activity of this important institution. All the various Departments of the College are represented by one or more papers and it is only possible here to mention some of the many valuable contributions, but they will serve to illustrate the wide field covered.

The Department of Agriculture contributes an account of its Field Work, and the following trials are recorded: Sugar Beet Manuring; Barley Manuring; Potato Varieties; Mangel Manuring; Pasture Investigation; Potato Virus Diseases. The same department has a section dealing with Farm Recording in which particulars are given of the Weather Records and the Effects on Crops as well as the dates of Drilling and Planting over a number of years correlated with dates of harvesting and the crop yields per acre.

Exhaustive reports on the activities of the Research Departments of Chemistry and Mycology appear, and Mr. S. G. Jary, B.A., the advisory entomologist, contributes two interesting articles, one on "Some Observations on Winter Moth Caterpillar Attack on Fruit Trees in 1929–

30," and the other an illustrated note on the life-history and control of the Strawberry and Raspberry Bud Weevil. Other entomological articles include one by Mr. M. D. Austin on "The Biology of the Apple Capsid and the Common Green Capsid," and another by Dr. A. F. Barnes of Rothamsted on "Observations on Gall Midges affecting Fruit Trees."

From the Economics Department, Mr. James Wyllie contributes an informative article on "Some Pointers in Farm Management," and Mr. M. A. Knox, B.Sc. (Agric.), writes on "Some Sugar Beet Costs and Returns."

In addition to the Report of the Department of Mycology there are a number of valuable articles by the mycologists of the College and their collaborators. "An Unusual Form of Hop Canker" is by Prof. Salmon and Mr. W. M. Ware, M.Sc. "The Control of Apple Scab" is the subject of two papers, one by Prof. Salmon, Dr. Goodwin and Messrs. Ware and Bagenal and the other by the first three of these authors. "A Blossom Wilt of Lavender" forms the subject of an illustrated article by Mr. Ware.

Messrs. Green, Moffatt and Parkinson contribute a well illustrated article on "The Identification of Commercial Species of Pea and Bean Seeds."

There are a number of important papers on soil classification and kindred studies which are sufficient to indicate the important place Wye is occupying in the movement towards a fuller utilisation of the soil. Prof. Linwood L. Lee of New Jersey writes on the possibilities of an international system for the classification of soils. Very little about the methods of the American and New Jersey systems of soil classification has found its way into print before, and so Prof. Lee's paper serves not only as a most important contribution to our knowledge of the soils with which he deals, but also places on record information about soil-survey work and soil classification which is not available elsewhere.

Other contributions on soil work include "The Nomenclature of Soil Classification," by Dr. S. Graham Brade-Birks, in which the author urges the general acceptance of the New Jersey System of soil classification in England and throughout the Empire, and an article by Mr. Basil S. Furneaux, M.Sc., entitled "Field Experience with the American System of Soil-Surveying," in which the method used by the author is fully explained.

Mr. R. M. Harrison, B.Sc., A.R.C.S., contributes two papers on weeds, and Prof. E. S. Salmon and Mr. A. H. Burgess, B.Sc., write on hops.

In his review of College activities, the Principal, Mr. R. M. Wilson, B.Sc., mentions the fact that an important feature of the College work is Mr. W. R. Dunlop's research in connection with Farm Management. This work originated at Wye in 1926 when Mr. Dunlop carried out his first investigation on the application of industrial psychology to agriculture. The scope of the work has now become wider and an attempt has been made during the past year to study critically the management of farms with the object (*a*) of endeavouring to suggest possible improvements in management technique, and (*b*) by examining the way in which the managerial mind works and the knowledge which the efficient manager actually makes use of, of formulating a special course of training for those who intend to take up farm management posts. The nucleus of such a course is being tested experimentally on a number of students with promising results. Since this research is the first of its kind to be carried out in Agriculture the results will no doubt prove to be of great general interest.

REPORT OF THE FOOD INVESTIGATION BOARD FOR THE YEAR 1930. Department of Scientific and Industrial Research. Pp. vii + 175, 9½ × 6. (London: His Majesty's Stationery Office, 1931.) Price 3*s*.

The Report of the Food Investigation Board of the Department of Scientific and Industrial Research for 1930 contains particulars of a large amount of research work that has been carried out by its Staff.

The first section is that relating to Meat. This includes an account of a survey of the changes in the air and other conditions surrounding the carcases of New Zealand lambs, and their effects on the carcases, from the freezing in New Zealand to the market in Great Britain, the main objectives in view being the lessening of the loss in weight that occurs between the first and last stages and the preservation of the appearance of freshness ("bloom") which is an important factor in the market value of the meat. Another problem is the extension of the time for which beef can be preserved by chilling, as distinct from freezing. Various other investigations involving chemical, physical, physiological and bacteriological work in connection with meat have also been undertaken.

Pig products constitute a separate section, comprising work on the freezing and storage of pork and mild-cured bacon, and on the scientific basis of curing. Frozen pig carcases are shipped from Australia and New Zealand, mainly for the pork market. But the demand for pork in Great Britain is a limited one compared with that for bacon, and the pig industry of the two Dominions could be expanded if it were possible to market their pig flesh in this country as bacon rather than as pork. Two methods of achieving this object have been suggested, first that frozen carcases should be shipped to Great Britain and there made into bacon, and secondly that mild-cured bacon should be manufactured in Australia and New Zealand and exported in a frozen condition. Experimental work has indicated that the first method should be possible, though there are a number of factors influencing the production, and delivery in Great Britain, of carcases that can be converted into good bacon. The second proposal presents difficulties that have not yet been surmounted.

In the section dealing with Fruit and Vegetables, apples and their problems have occupied a large amount of attention. The effect of storage under different conditions on the vitamin C content of apples is still a subject for further investigation, but indications so far, with Bramley's Seedling apples, a variety markedly rich in this vitamin, are that the vitamin content is not affected by storage under frozen conditions.

A section entitled " Biological Engineering " covers problems in that " particular field of reactions between stored materials and storage environment where control becomes intimately associated with biological factors." An account is here given of the model chamber at the Ditton Laboratory which was completed and brought into operation in the year under review. This was designed primarily for the study of problems of control in the cold storage of fruit, and an account is given of the methods of carrying out investigations that have been made possible with the equipment now available.

In this section there is also a record of work on the rate of evaporation from eggs as affected by various conditions influencing them in storage.

The subject of Canning covers investigations relating to the corrosion of tin and iron by fruit acids and other substances, and the factors affecting it ; and the section on Fish deals with such matters as the low temperature preservation of haddock, and methods of smoke-curing.

Finally there are accounts of work conducted at the National Physical Laboratory and at the Imperial College of Science and Technology. The former was concerned mainly with apparatus and methods for carrying out tests and determinations in the investigation of food problems, and the latter with chemical and biological matters relating to apples.

THE COCONUT MOTH IN FIJI. By J. D. Tothill, D.Sc., assisted by T. H. C. Taylor, B.Sc., and R. W. Paine, B.A. Pp. vii + 269, with 12 coloured and 22 black-and-white plates, 1 map and 121 text-figures, 10½ × 7½. (London: The Imperial Institute of Entomology, 1930.) Price 31*s*. 6*d*.

In this sumptuously produced volume the facts are given of what will in time doubtless become one of the classical instances of successful biological control of an insect pest. The important copra industry of Fiji was threatened with extinction due to the ravages of the caterpillar of a little moth known as *Levuana iridescens*. It was only during the last fifty or sixty years that this pest had become of economic importance in Viti Levu, one of the two large islands of the Fiji group. There it had rendered the cultivation of the coconut palm unprofitable and alarm was felt that it would spread and ruin the copra industry in the whole colony. Various methods of control were attempted with but little success. Attention was also directed to the possibilities of biological control. Levuana had no parasites attacking it and thus flourished unchecked. A search in neighbouring regions has failed to locate the existence of Levuana elsewhere. It is apparently known only from Fiji, although its comparatively recent notoriety there suggests that it is not native but an introduced insect. In 1925 a special campaign was instituted and amongst other activities an attempt was made to introduce into Fiji the parasites of a more or less allied moth, *Artona catoxantha*, which attacks coconuts in Malaya and Java but does little economic damage owing to natural control by parasites.

The volume contains a very interesting account of the difficulties encountered in making this introduction, not least being the long period during which the parasites had to be kept alive on the journey from Malaya to Fiji. As a result of good organisation and great care some 300 adults of a Tachinid fly *Ptychomyia remota* reached Fiji alive. It was of course not known then whether they would parasitise Levuana, but fortunately it was found that "the flies attacked them as though to the manner born." This point established, the parasites were bred on a large scale, great care being taken to destroy their super-parasites and to ensure that none of the latter should escape in Fiji. The flies were then liberated in batches of some 700 or so in various localities and quickly established themselves as an element of the fauna. Within six months they spread through that part of Fiji affected by Levuana. Coconut groves, formerly ashy-grey owing to excessive defoliation, became gloriously green, and when this report was written there had been no new outbreak of Levuana for three years, and the insect had become so scarce that a special search would fail to discover it except on a few isolated trees.

The successful result of this campaign is of great economic importance to Fiji. With threatened sugar and copra industries, attention had been directed to cotton, pineapples and dairying. The extinction of sugar would still be a calamity, but " the position could be faced to-day in a way that would have been impossible in 1922, because we now know that every acre of land under cane could be converted into dairy farms or coconut plantations, and that in the end the essential stability of the Colony would remain unimpaired."

TECHNOLOGIE DER TEXTILFASERN. Edited by Dr. R. O. Herzog. V. Band, 1 Teil. DER FLACHS. II. Abteilung. FLACHSSPINNEREI. By W. Sprenger. Pp. viii + 256, 9¾ × 6¾. (Berlin: Julius Springer, 1931.) Price RM. 38.

The first part of this work on flax, dealing with the botany, cultivation, preparation and marketing of the fibre, was referred to in this BULLETIN (1930, **28**, 396). The second part, which has now appeared, is devoted to the flax spinning mill, and gives a full account of the processes involved in the preparation of flax for spinning and its conversion into yarns. The equipment of the mill and the control and upkeep of the plant and machinery are carefully described and particulars are given of the numbering of the yarns and the methods of testing them. The book is copiously illustrated with photographs and diagrams of the various machines, and forms a valuable work of reference for flax spinners and others interested in linen manufacture.

NOTES COMPLÉMENTAIRES AU VOLUME " LA RAMIE-CULTURE (1925)." By Félicien Michotte. (Paris: Société de Propagande Coloniale, 1931.) Price 5 Fr.

This pamphlet, which has been written in extension of the author's long-continued propaganda in favour of ramie, consists largely of criticisms of the claims of various inventors to have devised commercially practicable methods of extracting and preparing the fibre. According to Michotte, all these inventions are worthless, but he regards their futility as evidence of the incapacity of their authors and by no means as an argument against the feasibility of " the rational exploitation of ramie " ; in fact, he still claims that this fibre could be so cheaply produced and so widely employed as practically to oust from the market the long-established textile materials, cotton, flax and hemp.

ARTIFICIAL RESINS. By Johannes Scheiber, Ph.D., and Kurt Sandig, Ph.D. Translated from the German by Ernest Fyleman, B.Sc., Ph.D., F.I.C. Pp. vii + 447, 8½ × 5½. (London: Sir Isaac Pitman & Sons, Ltd., 1931.) Price 30*s.*

The artificial resin industry has attained great importance in recent years, and this excellent comprehensive account of its underlying principles should be widely welcomed.

The first half of the book is devoted to theoretical considerations of the chemical and physical aspects of the subject and includes chapters on "The Typical Properties of Resins," "The Relations between Resinous Character and Chemical Constitution," "The Leading Principles of Resin Production," "Resin-Forming Polymerisation," and "Resin-Forming Condensations."

The main types of commercial synthetic resins (Cumarone and Aldehyde Resins, Phenol Aldehyde Resins, and Urea-Formaldehyde Condensation Products) are then dealt with at considerable length, special attention being given to their production, properties and uses.

The book contains numerous references both to original papers and the patent literature, and the regulations of the Association of German Electrical Engineers for the examination of electrical insulating materials are added as an appendix.

THE EMPIRE FORESTRY HANDBOOK, 1931. Edited by Fraser Story. Pp. 189, 8½ × 5½. (London: The Empire Forestry Association, 1931.) Price 3*s.* 6*d.*

This issue of the Empire Forestry Handbook has been prepared on essentially the same lines as that for 1930. In addition to revised lists of the members of the Empire Forestry Association, and of forest officers throughout the Empire, the new volume, however, contains a section comprising available statistics from official sources concerning the forest wealth of the Empire in respect of area, volume of standing timber, ownership of the forests, together with data regarding the approximate quantity of timber used and the trade (imports and exports) in timber of each part of the Empire, so far as figures are available. The most important section of the handbook is the revised list of Standard Trade Names of Empire timbers, prepared by the Timber Names Committee, which includes the suggestions made by all Forest Departments of the Empire in regard to the first issue of the list which appeared in last year's Handbook. The useful chapters dealing with higher forestry education, forestry research institutes in Great Britain, Canada, Australia, New Zealand, Union of South Africa, India and Malaya, as well as the references to the official departments, and institutions, in the United Kingdom dealing with imperial forestry, and to the arrangements made for the investigation of Empire woods, render this volume a very useful handbook to all those interested in the forests and timbers of the Empire.

ESTUDIO SOBRE LA VEGETACIÓN FORESTAL DE LA PROVINCIA DE CADIZ. By Luis Ceballos and Manuel Martin Bolaños. Pp. xviii + 353, 10¾ × 7½. (Madrid: Instituto Forestal de Investigaciones y Experiencias, 1930.)

This well prepared volume (in Spanish) is a record of an exhaustive study made by the authors of the forest vegetation of the Province of Cadiz and forms a valuable contribution to forest ecology.

It is divided into three sections. The first part contains a general description of the province, an account of its geography, geological structure and climate, with a résumé of the influence of the chief atmospheric agents on the vegetation. This section of the book concludes with a summary of the effect of all other factors that have an influence on the distribution of plant groups, analysing separately those that appear most important, the general remarks being illustrated by examples or definite references to the woods of the region studied.

The second, and in many respects the most important, part of the work is devoted to a study of the various plant formations occurring in the forests of the province, indicating their distribution and the area at present occupied by them, describing the forms and exterior aspects which usually distinguish them, and explaining the specific composition of each group in its most characteristic locality. The various associations described are arranged in the following groups : (1) Forest formations of Gymnosperms ; (2) forest formations of evergreen Angiosperms ; (3) forest formations of deciduous Angiosperms ; (4) general shrub formations ; and (5) shrub formations of sandy and saline soils.

The third part of the volume consists of a catalogue, arranged according to Engler's *Syllabus*, of all the woody plants observed by the authors themselves or mentioned by other writers as occurring in the woods of the province. The information provided in this catalogue includes the local common names, reference to works containing a botanical description of the tree, its distribution in the province and notes on features of special interest, including a list of associated plants with which it is found.

Short notes on the exotic trees acclimatised in the province, and some observations on those whose introduction is thought desirable and convenient, are given in an appendix.

The work is well illustrated with reproductions of photographs and sketch-maps and is accompanied by an excellent map in colour (scale 1 : 100,000), showing the distribution of the principal species of forest trees in the Cadiz Province.

AN OUTLINE OF FOREST PATHOLOGY. By Ernest E. Hubert. Pp. viii + 543, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1931.) Price 30*s*.

This volume by Professor Hubert of the School of Forestry, Idaho University, is the first general textbook on pathology dealing with all branches of the forestry industry in the United States. It is intended to be of interest and value not only to those engaged in sylviculture and the lumbering industries, but also to those concerned with the manufacture and sale of various forest products, including wood-pulp, and the erection and maintenance of wooden structures. Primarily written for conditions in the United States the treatment is sufficiently general for the information to be applicable also to Canada.

After a brief account of the normal structure and functions of a tree, the author groups the symptoms of disease and follows this by a key in tabular form indicating how these symptoms may be used for purposes of diagnosis. The principal tree diseases met with in North America, including under this head troubles due to non-organic agencies, are then dealt with in detail; an account being given for each of such points as history, the trees attacked, symptoms, causal agency, damage caused and control (if any). This portion of the book will naturally be of practical value mainly to those engaged in forestry and its subsidiary industries in the United States and Canada. Of wider interest is the concluding portion of the book, in which Professor Hubert treats of matters of world-wide interest under the heading "Wood Pathology." The properties of wood affected by decay and the relative resistance of wood to decay are discussed. Amongst specific troubles dealt with are dry rot, the decay of posts, mine timbers, etc., the decay and staining of logs and wood pulp, sap stains, etc. A short summary follows of the principal methods of controlling these various troubles.

Numerous illustrations and copious references to the literature of the subject add greatly to the value of this very useful work.

INDUSTRIAL MICROBIOLOGY: THE UTILIZATION OF BACTERIA, YEASTS AND MOLDS IN INDUSTRIAL PROCESSES. By Henry Field Smyth, M.D., Dr.P.H., and Walter Lord Obold, M.S. Pp. x + 313, 9¼ × 6. (London: Baillière, Tindall and Cox, 1930.) Price 27*s*.

The authors' object in preparing this work was to bring together in one volume the scattered information which has been recorded regarding the part played by micro-organisms in various industrial processes. Attention is primarily directed to the microbiological phase of each process, the source of the organisms involved, and the methods of obtaining them and of so controlling their activity as to ensure their proper functioning in the desired direction. Purely chemical phases of the processes are not considered in detail, but bibliographical references are supplied as a guide to the sources of such information.

The principal sections of the book are devoted to the microbiological production of acetic acid (including vinegar manufacture) and other carboxylic acids; the production of alcohols and ketones; the complex nitrogenous materials, including proteins, glue, gelatin, leather, etc.; carbohydrate materials, comprising wood, humus, textile fibres and their retting processes, ensilage, xylose and other products; fats and oils; fertilisers, sewage treatment and related problems; the spontaneous heating or "microbial thermogenesis" of various products, such as wool, skins, jute, hay, tobacco, coffee, cocoa and tanning barks.

Other sections deal with microbial food preparation; microbial formation of hydrocarbons, including coal, petroleum, phenols, and the microbiology of rubber latex; and with commercial enzyme production and the application of biological processes in industry.

The work gives a good review of the whole subject of the functions of bacteria, yeasts and moulds in connection with industrial processes, and should prove of great assistance to students and investigators and also to technical workers in the numerous branches of industry concerned.

LIFE MOVEMENTS IN PLANTS. Edited by Sir Jagadis Chunder Bose, M.A., D.Sc., LL.D., F.R.S., C.S.I., C.I.E. Pp. vi + 211, 8¾ × 5½. (London: Longmans, Green & Co., Ltd., 1931.) Price 18*s.*

This book forms Volume VI of the Transactions of the Bose Research Institute, Calcutta, a series devoted to a special study of movement in living plants. As is well known, Sir J. C. Bose's work has been devoted in large part to investigations of the ascent of sap and the transmission of impulse in plants, and he has brought forward evidence that these phenomena are the expression of the activity of the living protoplasm and not the outcome of purely physical factors. In the present volume Sir J. C. Bose collects the results of further work on these problems recently carried out by the staff and pupils of the Bose Research Institute, and he expresses the opinion that "it is difficult to see what further evidence can be demanded than that here presented in support of the physiological standpoint." Four groups of researches are concerned, comprising twenty-one papers published under the names of their authors. The first group is concerned with the ascent of sap which has been studied mainly in connection with the erectile response of selected leaves (*Centaurea* spp.). The next series records further work on the rhythmic pulsations in plants; while the third series deals with the transmission of impulse in plants and animals. The fourth group comprises four papers on biochemical subjects. Two are concerned with a study of the proteolytic enzymes of *Carica Papaya* and confirm the original view of Vines that the latex of the papaw fruit contains two distinct proteolytic enzymes, one digesting the higher proteins to peptone, the other limited in its action to converting the peptone into amino-acids. A third paper deals with the proteolytic enzyme occurring in the seeds of *Phaseolus Mungo*. The fourth study is a chemical examination of the Indian medicinal plants *Justicia Gendarussa* Burm. (two varieties) and *Eupatorium Ayapana* Vent. which are commonly confused by Indian druggists.

THE SOIL AND THE MICROBE. By Selman A. Waksman and Robert L. Starkey. Pp. xi + 260, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1931.) Price 17*s.* 6*d.*

In this book, the authors, who are respectively Professor and Assistant Professor of Soil Microbiology at Rutgers University, have provided a general introduction to the study of the whole microscopic population of the soil and its relation to soil processes and plant growth, microscopic organisms of the soil other than bacteria being included. The book deals with numerous aspects of the problem, from the weathering of the parent rock to the relationship of microbes to soil fertility.

The authors lay particular stress on the close dependence of higher plants and hence of animals and man upon the chemical processes brought about in the soil by bacterial activity, these processes including transformations of both organic and inorganic materials into forms suitable for nutrients for the higher plants.

The book, while giving a general idea of its subject, is somewhat unsatisfactory as a work of reference, the general arrangement being discursive and rambling. Though it appears to contain most of the main conclusions reached in this field of research, the evidence on which these conclusions are based is not given, and references to original literature are scanty. It appears to be on the whole a popular or introductory treatise, based on the senior author's comprehensive and authoritative work on the Principles of Soil Microbiology (see this BULLETIN, 1927, **25**, 352), which remains a standard book of reference on this subject.

HANDBUCH DER PFLANZENERNÄHRUNG UND DÜNGERLEHRE. Edited by Dr. F. Honcamp. Erster Band. Pflanzenernährung. Pp. xv + 945, 10 × 6¾. Price RM. 93. Zweiter Band. Dungemittel und Düngung. Pp. xii + 919, 10 × 6¾. Price RM. 86. (Berlin: Verlagsbuchhandlung Julius Springer, 1931.)

This publication follows the excellent arrangement of having a general editor for the whole, whilst each separate section is written by an expert in the particular subject dealt with. Although this plan may lead to a certain amount of unevenness in treatment, it is preferable in many respects to the alternative of one author attempting to treat the whole of such a vast subject.

The work is divided into two volumes, the first dealing with plant nutrition and the second with fertilisers and the theory and practice of their application.

The first volume opens with an historical account, by the editor, of the development of the study of plant nutrition, giving also short biographies of the outstanding workers. The second chapter deals at length with the constituents and composition of the plant as a whole, and is divided into two main sections, the first containing sub-sections on carbohydrates, fats and waxes, and nitrogen-containing organic compounds ; the second section deals with the inorganic constituents of the plant-body and the occurrence in plants of the various mineral elements.

The third chapter gives a concise account of the circulation of elements in nature, the movements of water, hydrogen, oxygen, carbon, nitrogen, sulphur and phosphorus being treated at some length and the remaining less important elements more briefly. Chapter IV deals with the physiology of plant metabolism, considered both from the point of view of the single cell and of the plant as a whole.

The fifth chapter passes to the consideration of the soil as habitat and food-reservoir of plants. The first section describes the main soil-types and gives details of their average mineralogical, chemical and mechanical composition. The second section deals with the chemical and physical properties of the soil and their relation to plant growth. Numerous aspects of the problem, such as the composition and importance of humus, reaction-phenomena in the soil, amount of water and gases present, are touched upon. In the third section, the importance of the soil from the biological aspect is taken up. The micro-flora and fauna of the soil, methods of estimating their numbers, the chemical reactions which they help to bring about, the effects of manuring, of partial sterilisation and of soil inoculation are among the subjects treated.

A short chapter follows dealing with the various attempts which have been made to formulate a definite relation between the various soil factors and the actual crop yields.

Chapter VII gives an account of water culture and small-scale experiments with plants, while Chapter VIII deals in considerable detail with field experiments, the theory of such experiments, their practical arrangement, the carrying out of experiments with individual crops and fertilisers, and the results obtained being described in turn. In the next chapter, the evaluation of the results of field experiments is considered.

The last chapter of this volume deals with the determination of deficiencies of plant food in the soil. The chemical methods of approach, by extracting the soil with a solvent of some kind, varying from water to a strong mineral acid, are first described. This is followed by a section on the biological and bacteriological methods more recently introduced. The method of Mitscherlich, based on " growth factors," is then described, and there is a detailed account of the Neubauer seedling method by Dr.

H. Neubauer himself. This includes practical recommendations, but it must be remembered that although Neubauer's own results undoubtedly give useful indications of potash or phosphate deficiency, the actual method of test is so highly technical and must be followed so exactly in detail that it has not yet found much application among other workers. The chapter closes with short descriptions of the methods proposed by Dr. H. Weissmann and Dr. M. von Wrangell, written by the authors themselves.

The second volume deals specifically with manures and their application. The first chapter gives a short historical account of the use of natural and artificial manures, followed by general considerations on the objects of manuring, the effects of manures on the soil and on the plant, with figures giving the consumption of artificial manures in different countries.

Chapter II deals with the various forms of natural manure, composts, farmyard manure, etc., and means of preserving and using them. Green manuring is also included under this heading. In the next chapter, the most important forms of artificial manure are treated in turn ; the German potash industry with the mode of occurrence, and methods of working the potash salts ; the various forms of lime and limestone used in agriculture ; the different varieties of phosphatic fertilisers with some account of their preparation ; the nitrogenous manures, including by-product ammonium sulphate, synthetic ammonia compounds, Chile saltpetre, " Norway saltpetre " or calcium nitrate, cyanamide and urea ; and the various mixed fertilisers. In each case information is given as to the methods of manufacture and, where necessary, of refining.

The next two chapters deal with general considerations on the application of artificial manures and with the practical details of manuring most of the important agricultural crops. This is followed by chapters treating on manuring as applied to forestry, to moor and heath soils and to ponds.

The final chapter describes the effects, both direct and indirect, of manures on the incidence of plant diseases.

The two volumes are separately paged and indexed, the indexing being carried out in a very thorough manner. The whole work is well produced, and although some sections may be unduly short, there is an enormous amount of information to be found. The references to original literature are extremely numerous and well arranged. The books should be very valuable works of reference.

FOUNDATIONS OF GEOLOGY, being a combination of OUTLINES OF PHYSICAL GEOLOGY prepared from the third edition of Part I of a Textbook of Geology by the late Louis V. Pirsson and Charles Schuchert, by Chester R. Longwell, pp. x + 356 (1930), and OUTLINES OF HISTORICAL GEOLOGY, second edition, rewritten by Charles Schuchert, pp. 328 + xlvii (Index), 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1931). Price 25*s.*

This interesting work is essentially a revision and combination of two well-known American textbooks by the late Louis V. Pirsson and Charles Schuchert respectively.

The first book, which comprises Part I of the present work under notice, has recently been published as a separate volume revised by Chester R. Longwell, and has duly been noticed in this BULLETIN (1931, **29**, 108).

The second book forms Part II of the present volume, and is a revised and rewritten edition of *Outlines of Historical Geology* first published in 1924 as Part II of *Introductory Geology* by Pirsson and Schuchert. The revised edition consists of 328 pages dealing with general stratigraphical and palæontological principles with special reference to the North American Continent, and is accompanied by a wealth of illustrations comprising numerous diagrams, restorations and comparative evolutionary sketches of the life of various geological eras, together with excellent photographic plates and maps, the latter including an interesting series of palæographical reconstructions of North America during successive stages of geological evolution.

The book as a whole is an admirable treatise on the "foundations of geology," and should prove of considerable value not only to American students for whom it is primarily designed, but to all engaged in the study of geological problems.

THE PRINCIPLES AND PRACTICE OF GEOPHYSICAL PROSPECTING. Being the Report of the Imperial Geophysical Experimental Survey. Edited by A. B. Broughton Edge, B.Sc., A.R.S.M., F.G.S., M.Inst.M.M., and T. H. Laby, M.A., Sc.D., F.Inst.P., F.R.S. Pp. xiii + 372, 11 × 8½. (Cambridge: At the University Press, 1931.) Price 15*s.*

The Imperial Geophysical Experimental Survey was formed under the joint auspices of the British Empire Marketing Board and the Commonwealth Government, who contributed £16,000 each to its cost. It was brought into being as the result of the co-operation of a number of scientific organisations both in England and Australia, and a highly qualified staff of physicists resulted.

The work of the Survey was augmented by the assistance rendered on the spot by the various Departments of Mines who, by drilling and shaft-sinking, obtained results without which the values of the geophysical observations and predictions could not have been assessed.

In the twenty-four widely separated localities which had been previously selected for trial in six of the States, fourteen were examined by electrical, five by magnetic, three by gravimetric and two by seismic methods. The results obtained by the Survey indicate that the outstanding applications for geophysical work in Australia are :

Electrical surveys for base metal ores (principally sulphides) in Tasmania and in other parts of the Commonwealth where the salinity of the surface and underground waters does not preclude the use of electrical methods.

Electrical surveys in saline water-bearing districts with a view to determining the distribution and character of the underground water supplies.

Gravimetric surveys in the brown-coalfields of Victoria and South Australia.

Magnetic surveys over the sub-basaltic tin and gold deep-leads of New South Wales, Victoria and Tasmania.

Seismic and gravimetric surveys in sub-alluvial gold and tin deep-lead areas.

The book contains not only a full account of the Survey's investigations, but an elaborate scientific description of the various geophysical methods in use, including much information of the instruments employed, and may be considered a valuable textbook. It is abundantly illustrated with plans, photos and diagrams, and its printing and get-up are a credit to the Cambridge University Press. Moreover, its moderate price should appeal to all students of the science.

THE GEOLOGY OF MALAYA. By J. B. Scrivenor, M.A., F.G.S. Pp. xx + 217, 8¾ × 5¾. (London : Macmillan & Co., Ltd., 1931.) Price 16s.

This book is a companion volume to the author's well-known *The Geology of Malayan Ore-Deposits*, and summarises in an interesting and lucid manner the salient features of Malayan geology.

The occurrence, distribution and general petrographic descriptions of Malayan rocks, whether igneous, volcanic, sedimentary or metamorphic, are discussed in some detail while observations are made regarding the mechanical and chemical effects of weathering under tropical climatic conditions. In addition, a brief account is given of some forty minerals apart from those mentioned in the former work, while a chapter is devoted to a consideration of rocks and minerals of economic interest other than ores. Peculiar, jet-black, spherical to oval glassy material with a finely sculptured, glossy surface, is described under the name of " tektite," and is considered provisionally to represent meteoric glass.

In a concise statement regarding the recent geological controversy of the geology of the Kinta Valley, the author states that he is in essential agreement with the succession made out by Dr. R. H. Rastall, *viz.* : (1) Recent alluvium ; (2) High-level alluvium, i.e. the Gopeng Beds ; (3) Western Boulder-clays ; (4) Intrusion of Mesozoic granite ; (5) Schist Series and Tekka Clays (Triassic) ; (6) Limestone (Carboniferous or Permo-Carboniferous). The author, however, preserves an open mind regarding the position of the Western Boulder-clays and the nature of the Tekka Clays.

The work is completed by 33 text-diagrams, maps and photographic reproductions, a useful bibliography covering the whole field of Malayan geology, whether economic or otherwise, an index, and a coloured geological map of Malaya on a scale of 12 miles to an inch, revised to 1930.

This book, with its companion volume, is a valuable addition towards the elucidation of Malayan geology, and should prove of considerable assistance to those interested in this country particularly from a tin-mining point of view.

THE GOLD RESOURCES OF THE WORLD. An Inquiry made upon the Initiation of the Organising Committee of the XVth International Geological Congress, South Africa, 1929, with a Summary by A. C. Sutherland, M.A., M.C.E., A.M.I.C.E. Pp. xiv + 457, 56 text figures and 38 plates. (Pretoria : Bureau of the XVth International Geological Congress, 1930.) Price 25*s.*

The policy, intitiated in connection with the Stockholm Session of the International Geological Congress in 1910, of compiling special studies of the world resources in certain mineral deposits, having resulted in a series of very valuable publications (e.g. *Iron Ore Resources, Coal Resources, Pyrites Resources,* etc.), the Organising Committee of the XVth Session in South Africa (1929) decided to initiate an enquiry into the Gold Resources of the World, the results of which are dealt with in the present volume.

Unfortunately reports from some of the countries were not received in time for publication, so that the following (mostly minor producers of gold) are not represented in the volume under notice: Abyssinia, Argentina, China, Czechoslovakia, Formosa, Guatemala, Honduras, Kenya, Jugoslavia, Nicaragua, Panama, Portuguese East Africa, Turkey and Venezuela. In 1927, the aggregate gold production of these countries amounted to about 335,000 oz.

Taking the British Empire first, under Canada, H. C. Cooke gives a good account of the saddle-reefs of Nova Scotia, and of the McIntyre, Hollinger (with plans and sections) and Dome mines of Porcupine, and of the Teck-Hughes, Lake Shore, Wright-Hargreaves and Tough-Oakes mines of the Kirkland Lake area, and the Noranda, Flin-Flon and Mandy mines of Manitoba. The placer deposits of the Yukon, British Columbia, etc., are described by W. A. Johnston.

The Gold Coast is dealt with by Sir Albert Kitson. The transverse section by O. A. L. Whitelaw showing banket occurring at the bottom of a syncline at a depth of between 7,000 and 8,000 ft. is interesting, considering that the present depth of mining has not yet reached 2,000 ft.

India, by Dr. L. Leigh Fermor, has a good geological sketch-map of the Kolar goldfield, and a vertical longitudinal section of the ore shoots in the Champion lode.

New Zealand, by J. Henderson, Director of the Geological Survey, includes a plan and section of the Waihi lodes.

Queensland, by C. C. Morton, includes a cross-section of the Day Dawn lode, Charters Towers, a geological section through Mount Morgan, and of the northern end of the Gympie goldfield.

The Union of South Africa has several contributors. A. W. Rogers describes the Witwatersrand goldfield, and gives a section across the Main Reef series and overlying beds at the Crown mines, and a section through the City Deep mine. The goldfields of Pilgrims Rest and Sabie are described by W. Wybergh, and the De Kaap goldfields by A. L. Hall. H. Pirow, the Government Mining Engineer, writes on economic aspects and the premium on gold. A table shows the production of gold in the Union from 1884 to 1928. In 1902, the Union produced 18·9 per cent. of the world's production, and in 1928, as much as 53·1 per cent.

Southern Rhodesia is by B. Lightfoot, of the Geological Survey, who describes the Cam and Motor, Globe and Phœnix, Rezende, Shamva and other well-known producing mines.

Tasmania is by A. McIntosh Read, Director of Mines. The 1927 production amounted only to 4,860 oz., nearly half of which came from the copper ore-bodies of Mt. Lyell. Increased production may be expected from the Read and Rosebery zinc-lead ore-bodies, which carry a good proportion of gold.

Victoria is by W. Baragwanath, Director of the Geological Survey. Sections show the geological structure of the Ballarat East and West goldfields, the Great Extended Hustler's shaft, showing saddle reefs and lava dyke to a depth of 3,454 ft.

Western Australia, by J. Blatchford, Government Geologist, includes sections of deep leads, plan and section of one of the most important alaskites being worked in the Westonian field, and another of the Mount Morgans mine, Mount Margaret goldfield. A good bibliography is included.

Among foreign countries, it must be admitted that the section devoted to the United states, occupying as it does about twenty-four pages of text and thirteen tables of production, and a graph showing the production of gold by classes of ore from 1848 to 1927, is the most complete and satisfying of all.

Each gold-bearing State is described by members of the U.S. Geological Survey, e.g. G. F. Loughlin is responsible for Colorado, H. G. Ferguson for Nevada and the Philippine Islands, and D. F. Hewett for the Appalachian Region, Arizona, New Mexico, Oregon and South Dakota.

Brazil, by Dr. Euzebio Paulo de Oliveira, includes a brief description of the famous Morro Velho mine.

The Dutch East Indies, by Dr. A. C. de Jongh, includes a good description of the Lebong district of Sumatra, with interesting plans showing the Soelit and Tandai veins cut up by faults.

Hungary, by Dr. M. Pálfy, consists mainly of descriptions of auriferous territories now belonging to Rumania and Czechoslovakia. At present there is no production of gold in Hungarian territory, although it is known to occur with copper and other ores.

The section on Korea, compiled by the Governor-General of Chosen, includes geological maps of the Unsan and Shōjō goldfields.

A good bibliography is included in the section on Mexico, by L. Salazar Salinas.

The sketch of the gold deposits of U.S.S.R., by D. Mushketov, covers fifteen pages of text and includes a sketch-map indicating the gold-bearing areas.

South America, except Brazil, by Luis Flores de Morals Rego, includes very brief descriptions of Uruguay, Argentina, Chile, Peru, Bolivia, Ecuador, Colombia and the Guianas. A table shows the gold production of these countries from 1900 to 1927.

Of the forty-nine countries dealt with in *The Gold Resources of the World*, reserves of available ore on January 1, 1928, are given only for eighteen of them, which are summarised by A. C. Sutherland on page 30 of that work.

The world's gold production has remained fairly steady in recent years, and as yet shows no signs of a serious decline. The British Empire production has shown a more or less gradual increase from 11,337,000 oz. in 1920 to 14,100,000 oz. in 1929. A further increase will probably be shown for the year 1930.

WORLD SURVEY OF THE ZINC INDUSTRY. A Study made for the Committee on Foreign and Domestic Mining Policy of the Mining and Metallurgical Society of America. By W. R. Ingalls. Pp. 128, 9 × 6. (New York: Mining and Metallurgical Society of America, 1931.) Price $2.25.

This work by W. R. Ingalls, probably the greatest American authority on zinc, should be carefully studied by all interested in the industry.

The author points out that the ore of Holston River district of Tennessee is the only lead-free zinc sulphide of importance in the United States. He does not believe that the electrolytic process will displace distillation and gives his reasons for this in Chapter X. Although Waelz fume is followed by electrolytic extraction in Poland, in Donora, United States, it is followed by distillation. Spelter ("horsehead" and "Bertha" brands) distilled from New Jersey willemite is of about the same grade as electrolytic (99·95–99·97 per cent.). Continuous distillation has now entered into the commercial stage.

The author points out some reasons why zinc consumption is less in the United States than formerly, e.g. a zinc coating for galvanised sheets, formerly 2 oz. per square foot, is now frequently 1 oz. per square foot (approximately ·0015 in.), while an electro-galvanised coating is only 0·00015 to 0·00045 in. thick. Copper-zinc alloy, formerly 2 : 1, has often now an increased amount of copper, and, for domestic purposes, copper tubing has largely replaced brass tubing. He considers that new uses for zinc "is not so much a matter of scientific research, whereof much has been done, as it is of sales promotion."

Chapter XVI is a survey of American mines, and Chapter XVIII of foreign mines.

The reserves of the American zinc-lead mines are given as 9,149,480 short tons of zinc and 2,007,979 tons of lead (proportion of zinc to lead as 4·35 : 1), and the reserves of foreign zinc-lead mines as 23,812,000 tons of zinc to 13,120,300 tons of lead (proportion of zinc to lead as 1·8 : 1), a somewhat remarkable comparison.

The lead-zinc ores of the United States are of distinctly lower grade than those of European origin.

HANDBUCH DER ANORGANISCHEN CHEMIE. Edited by Dr. R. Abegg, Dr. Fr. Auerbach and Dr. I. Koppel. Vierter Band, Dritte Abteilung. DIE ELEMENTE DER ACHTEN GRUPPE DES PERIODISCHEN SYSTEMS. Zweiter Teil. EISEN UND SEINE VERBINDUNGEN. A Lieferung I. Atomgewicht (Jul. Meyer), Eisenatom (E. Rabinowitsch), Darstellung von reinem Eisen (K. Fischbeck), Kolloides Eisen (D. Deutsch), Physikalische Eigenschaften (K. Fischbeck), Elektromotorisches und elektrochemisches Verhalten (H. Danneel). Pp. xvi + 336, 10 × 7. (Leipzig: Verlag von S. Hirzel, 1931.) Price RM. 40.

With the commencement of the section of Abegg's "Handbuch der Anorganischen Chemie" dealing with Iron, this comprehensive work approaches completion.

The present section, the latest addition to the series, includes chapters on the atomic weight of Iron, the Iron atom and its spectroscopy, the preparation of pure Iron and its physical and physico-chemical properties.

The high standard of the previous publications in this series is adequately maintained, and this should prove an extremely useful reference book to those interested in Iron and its properties.

An account of the alloys and technology of the metal is to be included in the next part of this volume, which now is in course of preparation.

DETERMINATION OF THE OPAQUE MINERALS. By C. Mason Farnham. Pp. vii + 236, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1931.) Price 17*s.* 6*d.*

This book deals with the special methods used by the author in his work on the determination of opaque minerals, and consists mainly of descriptive matter concerning these minerals together with revised determinative tables.

The principal distinctive features considered are those determined by the etching of polished sections by various chemical reagents.

Although containing much useful information and some particularly valuable tables of properties, the book suffers in places from lack of accuracy in detail, and the extensive use throughout the text of unusual abbreviations may tend to confuse the student.

Nevertheless the book contains fuller information on the metallic minerals dealt with than any previously published, and serves a useful purpose.

GEOLOGY OF PETROLEUM. By William Harvey Emmons, Ph.D. Pp. xi + 736, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1931.) Price 30*s*.

· The first edition of Emmons' Geology of Petroleum appeared in 1921. Since then many new fields have been discovered in the United States and in other parts of the world, mainly owing to advances in petroleum geology, and many wells have been drilled to greater depths owing to improvements in technology. In this new edition all the chapters of the first edition have been re-written and greatly enlarged. About half the illustrations have been discarded, and some 350 maps, cross-sections and other illustrations have been added.

More is heard to-day of over-production than conservation, but the author in the preface points out that many of the greatest fields in the Mid-Continent region are developed in the lowest beds that are known to contain oil. New fields may be developed on other structures, but the future production of these deep fields can come only from the deposits that are now known. "Even admitting further improvements in technology, it is a rational conclusion that a few decades will see a serious shortage of oil, especially in North America where development and exhaustion have gone ahead more rapidly than in other Continents."

The first 194 pages of the work may be regarded as introductory, and describes surface indication, openings in rock, origin of petroleum and natural gas, structural features of oil and gas reservoirs, metamorphism of petroleum by dynamic agencies, etc.

About 77 pages of text are devoted to Eastern United States, 182 pages to the important Mid-Continent region, 30 pages to the Gulf Coast, 70 pages to the Rocky Mountain region, and 48 pages to the Pacific Coast. The petroleum deposits of the rest of the world are treated in the remaining 148 pages of the book. The sections on Canada, Mexico, Venezuela, Peru, Germany, Poland, Russia, India, Dutch East Indies and Japan being especially good.

Of the new fields discovered in the United States during the last ten years, the following are among the most important :

In the Eastern United States, the Big Sinking field, a south-eastern extension of the Irvine field, is now one of the most productive oilfields in Kentucky, and the Muskegon field of Western Michigan (1927) has been one of the most productive oilfields west of the Mississippi River.

Discoveries have been numerous in the Mid-Continent fields, e.g. Churchill and Oxford (1926, 1927) now amongst the foremost in Kansas. In Oklahoma, Burbank field (1920), which up to 1927 yielded 130,000,000 barrels of oil from 2,000 wells—Tonkawa field, production about 77½ million barrels up to 1926—Oklahoma City Pool (1928), one of the greatest oil pools in the United States. In Seminole County, Cromwell (1923), Wewoka, Seminole City, Earlsboro' and Searight fields (1926), Bowlegs and Little River fields (1927). By August 1927 the production of the Seminole region reached a daily output of 527,400 barrels of oil and exceeded that of light oil of any other field in the United States.

Gas was discovered in the Panhandle district of North Texas in 1918 and oil in 1921, and has proved to be one of the greatest gas fields in North America. Oil is obtained from Ordovician limestone at a depth of 8,514 ft. in the Big Lake oilfield of Texas, discovered in 1923. The Yates and the Hendricks, both first drilled in 1926, rank among the great oilfields of the world.

In Arkansas, the Smackover field, discovered in 1922, rapidly developed into one of the most productive oil and gas fields of North America.

The Lockport dome, south-east of Sulphur, has proved to be one of the most productive salt domes of Louisiana, and the West Columbia salt dome of Texas, the most productive of the domes in the Gulf Coast region.

In the Rocky Mountain region, the Kevin-Sunburst oilfield of Montana, discovered in 1922, is one of the most productive of the region.

In California, Los Angeles basin encloses a group of the most productive oil-bearing areas of the world, e.g. Huntington Beach (1920), Long Beach (1921), Dominguez (1923), Rosecrans and Inglewood district (1924).

This work is an admirable textbook for students of petroleum geology, and, for reference purposes, is indispensable to petroleum geologists.

MODERN BRICKMAKING. By Alfred B. Searle. Pp. xvi + 544, 9¾ × 7½. Third edition, revised and enlarged. (London: Ernest Benn Limited, 1931.) Price 63*s.* net.

The third edition of this book, which bids fair to become the standard work on the subject, is profusely illustrated with reproductions and diagrams of modern machinery and kilns.

A new feature of the work is the incorporation, at the end of the appropriate chapters, of lists of kiln builders, firms manufacturing brickmaking machinery, etc. This inclusion may be of use, especially to those not having access to trade catalogues, but it should be understood that the lists do not pretend to be exhaustive.

The book deals principally with clay and its winning, and with the various methods of brick manufacture, and there is also a chapter on kilns and firing. Chapters giving information on sand-lime, slag, glazed, perforated, vitrified, porous, hollow and ornamental bricks are also included.

The author in his preface to this edition draws attention to the fact that the work is intended to be "chiefly used by those who desire to ascertain the best plant and processes to use for the clays and other materials available to them." Experienced brickmakers will probably be able to amplify the information given on the various processes and judge their applicability to their own raw materials, but from the layman's and prospective brickmaker's point of view it is doubtful whether the descriptions contain in all cases sufficient detail to enable them to adopt the procedure best suited to the clay in which they are interested.

The book should be of great assistance to brickmakers, and in making its appearance at this time of world depression and fierce competition, it should afford suggestions to manufacturers in regard to modernising their plant and, where necessary, to improving the quality of their goods, in an attempt to regain those markets which may have been lost through insufficient technical knowledge and adherence to old-fashioned methods.

MODERN TILEMAKING. By Alfred B. Searle. Pp. 430, 8½ × 5½. (London: H. Greville Montgomery, 1930.) Price 12*s.* 6*d.*

This book renders more readily available the series of articles which appeared in serial form in *The British Clayworker.*

Mr. Searle is doing much useful work in collecting, in the many textbooks of which he is now the author, such information, of value to many practical men, but it is to be regretted that the pleasure of reading his books is somewhat marred by the occasional reiteration of the same facts on different pages.

This book contains much information of value to those interested in the manufacture of tiles, particularly in relation to those for roofing. The short chapters at the end of the book on paving and other vitrified tiles; encaustic tiles; ornamental, porous and hollow tiles; and on the glazing and testing of tiles, although useful, have rather the appearance of having been added as an afterthought.

The book can, however, be recommended as a useful practical treatise by an author well aware of the difficulties likely to be encountered in the processes with which he deals.

CEMENT CHEMISTRY IN THEORY AND PRACTICE. By Professor Dr. Hans Kuhl, translated by J. H. Christelon, B.Sc. Pp. 64, 9 × 6. (London: Concrete Publications Limited.) Price *7s. 6d.*

This book, which is a translation from the German, is a valuable contribution to research work on the chemistry of cement. The author summarises the work of previous investigators and details the lines of research upon which he has been engaged for the past twenty years.

A description is given of the methods he has originated for applying technical tests for setting time, soundness, tensile and compressive strength to the small quantities of the cements prepared in the course of his investigations, thus enabling the results of the exact research methods of physical chemistry to be supplemented by technical tests.

The reactions occurring between the components of the raw cement mixture at various temperatures in the kiln are fully discussed, and the author draws attention to the erroneous conclusions reached by other investigators who have studied the reactions between pure materials only, thus ignoring the effect of iron oxide and other constituents of the raw mixture.

The work of previous investigators on the constitution of Portland cement clinker is summarised in Part 3 of the book, the chemical composition and physical constants of the mineral constituents of various cement clinkers being given and the properties of the minerals described.

In considering the problem of the setting and hardening of Portland cements, the author refers to both the crystalline and gel theories, and in connection with the former theory, he again points out the erroneous conclusions arrived at by other investigators, instancing that due to the assumption that the reactions occurring when a few grains of cement are immersed in a relatively large volume of water are necessarily the same as those which take place when cement is gauged in the ordinary manner.

Parts 5 and 6, which form the last two chapters of the book, deal respectively with the chemistry and technical aspect of high-strength cements. In these chapters modifications of the " silicate modulus " are discussed in their bearing upon the fusibility of the clinker and strength of the cement, and the generally accepted view that the quality and strength of the cement are directly proportional to the fineness of grinding is shown to be incorrect in those cases where the lime content has been kept somewhat low. This portion of the book should prove of great interest and value to cement manufacturers, some of the matters dealt with being the author's formulæ for the proportioning of the raw mix, the use of fluxes in burning and an interesting account of his work upon the influence of the granular composition of the cement on its strength.

The book, which is illustrated with several excellent photomicrographs, can be strongly recommended to those desirous of acquiring an up-to-date knowledge of the subject.

REINFORCED CONCRETE BRIDGES. By W. L. Scott, M.Inst.C.E., assisted by C. W. J. Spicer. Third edition. Pp. xii + 268, 9¼ × 6. (London: Crosby Lockwood and Son, 1931.) Price 28*s*.

In his preface the author of this highly technical volume states that although bridge work is often dealt with in books on the subject of reinforced concrete, " there appears to be no reference available in English which is wholly devoted to these structures or which covers the subject in a manner sufficiently comprehensive for the practical use of the engineer." Mr. Scott has accordingly attempted to meet this need, and to amplify the information available elsewhere. Although the scope of the work is not sufficient for him to cover the subject exhaustively, he claims that " the information comprises all that is essential to guide an engineer in the adoption and the design of a bridge to suit any case ordinarily met with." He has furnished particulars of the best and most recent practice, much of the information being given in English for the first time.

The work, which is now in its third (and enlarged) edition, is copiously supplied with diagrams, photographs, mathematical formulæ and tables, and should prove very useful to the engineers for whom it is written.

Coral Reefs and Atolls, Being a Course of Lectures Delivered at the Lowell Institute at Boston, February 1930. By J. Stanley Gardiner, F.R.S., F.R.G.S. Pp. xiii + 181, 9 × 6. (London: Macmillan and Co., Ltd., 1931.) Price 10*s.* 6*d.*

This book, which is based on a series of lectures delivered by the author at the Lowell Institute, Boston, U.S.A., during February 1930, is mainly of a biological character, many of the biological observations being made by the author during five years' work on coral reefs.

The work comprises eight chapters dealing respectively with a general introduction to the subject of coral reefs and atolls, together with observations regarding the formation of coral islands (Chapters 1 and 2); the natural history of animal and plant reef builders (Chapters 3, 4 and 5); the distribution of coral reefs (Chapter 6); atolls and their lagoons (Chapter 7); and, finally, a consideration of the foundations of atolls (Chapter 8). There is a useful appendix of 14 pages giving supplementary information regarding various islands and coral reefs in the Pacific Ocean, in addition to fifteen interesting photographic plates, thirty-three text-diagrams and maps, and an index.

The work is a welcome addition to the already extensive literature on corals and atolls, and is particularly valuable, coming as it does from a recognised authority on the subject, who, moreover, is professor of zoology and comparative anatomy in the University of Cambridge.

A Practical Handbook of Water Supply. By Frank Dixey, O.B.E., D.Sc., F.G.S., F.R.G.S. Pp. xxviii + 571, 8½ × 5½. (London: Thomas Murby & Co., 1931.) Price 21*s.*

In the course of his work as a Government Geological Surveyor in various parts of Africa, the author of this book has been impressed with the need of a practical handbook to which settlers, missionaries, administrative officers, engineers and others can turn for information when faced (as they so often are) with the problem of developing a small local water-supply. To meet the need, Dr. Dixey has written this volume, and he has succeeded in producing something that should be of real value to the many residents in arid and semi-arid areas who are inexperienced in the search for and development of an adequate supply of water.

After an introductory statement on water resources, the book deals with surface water supply at some length, and then goes on to discuss the origin and distribution of groundwater supply with details regarding the geological conditions under which it accumulates. The quality of water is next considered (its examination, purification and the methods employed for keeping supplies free from contamination), and then follows a chapter on water-finding methods, including some remarks on water-divining. The next chapter, which occupies 122 pages, deals with the various methods for the recovery of ground-water, and is of a thoroughly practical nature, embracing as it does an abbreviated account of the various types of wells and of water-raising equipment. The book concludes with a general statement on the water-supply conditions of southern, central and eastern Africa so far as they are known at present.

The book is a very useful one, and one that fills a decided gap. It is well written, well printed and illustrated, but perhaps rather too long for an elementary handbook. A considerable number of references for further reading are incorporated in the text, and one feels that the practical value would not have been impaired by abbreviation in many places.

McGRAW-HILL WORLD MAP OF THE MINING AND METALLURGICAL INDUSTRIES (EXCLUDING FUELS). 3 ft. 4 in. by 2 ft. 4 in. (New York: McGraw-Hill Publishing Co., Inc., 1931.) Price $1.00.

This publication exhibits a considerable amount of information in a convenient form. It consists of a map, on which are drawn on Mercator's projection the various continents of the world, surrounded by statistical matter. Columnar diagrams show the world's outputs of ten primary metals each for the years 1921 to 1930 made by the chief metallurgical countries, and tables of the various mineral outputs for the year 1929 (or earlier years when only available) of all the mining countries.

On the map itself are shown by patches of green the metallic-ore producing districts, and by red those of the non-metallic minerals, while tributary smelters and refineries are indicated by groups of red circles. As the chief buying centres for machinery and supplies are also indicated, the map should be specially of value to manufacturers and exporters.

RECENT ADVANCES IN ANALYTICAL CHEMISTRY. Edited by C. Ainsworth Mitchell, M.A., D.Sc., F.I.C. Vol. I. Organic Chemistry. Pp. x + 421. Vol. II. Inorganic Chemistry. Pp. xiv + 452, 8 × 5¼. (London: J. & A. Churchill, 1931.) Price 15*s*. each volume.

The aim of this work is to present to the chemist, in a convenient, summarised form, the advances which have been made, in the last decade, in the various branches of analytical chemistry. Volume I deals with organic chemistry and Volume II is devoted mainly to inorganic chemistry.

The subjects dealt with in the two volumes, however, overlap to some extent, Vol. I including chapters on Coal; Petroleum and its Hydrocarbons; and Gas Analysis; whilst Water and Sewage Analysis is dealt with in Vol. II. Both volumes are divided into sectional chapters which have been written by specialists, under the editorship of Dr. C. Ainsworth Mitchell. Each section begins with a concise, critical summary of the methods in use up to eight to ten years ago, with references to the original literature and to English abstracts. Subsequent advances are discussed more fully and working details of new methods are given.

In the first chapter of Vol. I, Mr. Hinton deals with sugar analysis. The various methods of determining reducing sugars by means of copper are fully discussed, and special attention is given to Lane and Eynon's method for the volumetric estimation of reducing sugars using methylene blue as an internal indicator. The oils and fats are excellently dealt with by Dr. Mitchell in Chapter II and Mr. Parry contributes the next chapter on the essential oils.

A lucid account of modern developments in the chemistry of the proteins has been written by Dr. Dorothy Jordan Lloyd. Kingston and Schryver's carbonation method for the separation of the products of hydrolysis of gelatin into individual amino-acids is described, and mention is made of the new amino-acids which have been isolated in recent years. A brief account is given of the analysis of proteins by means of the proteolytic enzymes—a method which ultimately should add considerably to our understanding of the architecture of the protein molecule. It must be admitted, however, that in the present state of our knowledge the analytical investigation of the proteins is a research undertaking outside the province of the analyst. Dr. Harriette Chick supplements the section with a short description of the biological analysis of the proteins.

A chapter on the tannins is supplied by Dr. Mitchell. The section on the cereals by Dr. D. W. Kent-Jones is notable for a penetrating examination of the value and accuracy of methods used in that branch of analysis. "Milk and milk products" is the subject of a section by Mr. Elsdon and a useful chapter on paper has been written by Mr. William Dickson. Dr. King and Mr. Acton-Taylor collaborate to contribute two chapters, the first on petroleum and the second on coal. The volume ends with Mr. Amber's valuable chapter on gas analysis.

In Vol. II working details of new methods are not in general given to the same extent as in Vol. I, but the copious references to literature will enable those interested to find fuller information. It is satisfactory to note that the work of Dr. Schoeller and his collaborators on the rare earth metals and other rare elements is described in detail, as his extremely valuable methods are not yet readily available in book form.

This volume deals also with hydrogen ion concentration ; the common and rare metals ; the solid and gaseous constituents of steel ; carbon and carbon blacks ; silicon ; and microchemistry.

· It is to be hoped that Dr. Mitchell will keep these volumes up-to-date by frequent revision, for it is impossible to overestimate their value to the busy chemist.

It is extremely useful to have, in such a concise and readable form, a summary of new methods and references to original papers, and apart from their value to all progressive analysts, the volumes should act as a stimulant to those having a tendency to adhere to old-fashioned ways.

THE SOVIET FIVE-YEAR PLAN AND ITS EFFECT ON WORLD TRADE. By H. R. Knickerbocker. Pp. xx + 245, 7¼ × 5. (London : John Lane, The Bodley Head, Ltd., 1931.) Price 8*s*. 6*d*.

In this book the author has recounted his experience during a second visit to Russia in 1930, when, as foreign correspondent to the *New York Evening Post*, he travelled 10,000 miles in two months along the chief industrial salients instituted under the Soviet Five-year Plan, chiefly to the south and east of the Ural region.

The book gives a first view of a series of the largest industrial undertakings in the Soviet Union. Perhaps the most important of these is the Magnetogorsk iron and steel works, of which the Soviet intends to make the second largest plant in the world, producing 3,000,000 tons of pig iron a year, near the Magnet Mountain to the east of the Urals, where there are estimated reserves of 275 million tons of 62 per cent. iron ore. A railway is to be built to the Kuznetz coal basin, 1,500 miles further east, where another iron and steel plant is to be built. Coal is to be carried west to the ore plant, and iron ore east to the other, so that both plants can be kept going At first sight, when the great transport problems involved and the isolation of the places are considered, the double project hardly seems promising, but it is being pushed forward under American direction with much energy, as are most of the other undertakings.

Other undertakings visited included the Azbest deposit of asbestos, which is thirty-six miles long and is estimated to contain 12,000,000 tons of high-grade fibre ; the largest tractor plant in the world at Cheliabinsk ; the motor-car plant at the new Nijny-Novgorod, in connection with which a £6,000,000 contract was made with Henry Ford ; a saw mill on the Volga where there was one consignment of 100 rafts each containing 10,000 cubic metres of timber—the Soviet Government hopes to cut, in 1932, three times as much timber as the United States ; the Gigant state wheat farm, the largest in the world, but apparently not paying its way ; the manganese mines at Chiaturi in Georgia ; the Baku oil industry ; the Dnieprostroy, which will be the largest hydro-electric plant in the world ; and the Donetz anthracite coal mines, where the author's description of the bad working conditions explains why there are low output results.

Most of the industrial undertakings are being pushed forward with the aid of capitalist methods such as piece-work, premiums and holidays, under the direction of technical experts from the United States and elsewhere.

Discussing the probable success of the Plan, the author thinks that first judgment would brand it as a failure, but, in spite of big mistakes that have been made, it seems possible the end may be achieved.

The book is one of exceptional value as an unbiassed and most interesting account of the political, social and industrial conditions associated with the efforts of the Soviet Government to carry out its Five-year Plan.

BOOKS RECEIVED FOR NOTICE

SEEDING AND PLANTING IN THE PRACTICE OF FORESTRY. By James W. Toumey, M.A., F.D., Sc.D. Second edition, revised and enlarged by Clarence F. Korstian, M.F., M.A., Ph.D. Pp. xviii + 507, 9 × 6. (New York : John Wiley & Sons, Inc. ; London : Chapman & Hall, Ltd., 1931.) Price 25*s.*

THE MECHANICAL PROPERTIES OF WOOD. By George A. Garratt, M.F. Pp. ix + 276, 9 × 6. (New York : John Wiley & Sons, Inc. ; London : Chapman & Hall, Ltd., 1931.) Price 17*s.* 6*d.*

BULLETIN OF THE IMPERIAL INSTITUTE

A RECORD OF PROGRESS RELATING TO
AGRICULTURAL, MINERAL AND OTHER
INDUSTRIES, WITH SPECIAL REFERENCE TO
THE UTILISATION OF THE RAW MATERIALS
OF THE DOMINIONS, COLONIES AND INDIA

VOL. XXIX. NO. 4
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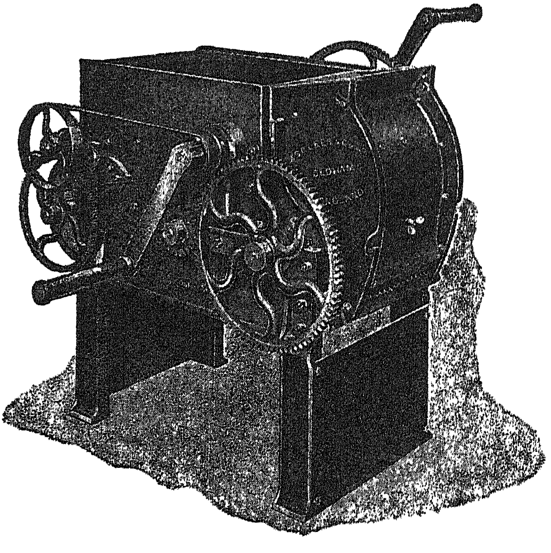

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CORAL REEFS AND ATOLLS. Being a Course of Lectures delivered at the Lowell Institute at Boston, U.S.A., February 1930. By J. STANLEY GARDINER, F.R.S., Professor of Zoology and Comparative Anatomy in the University of Cambridge. Illustrated. 10s. 6d. net.

"Every geographer, biologist, and oceanographer will find this book of the greatest value."—*The Geographical Journal.*

THE GEOLOGY OF MALAYA. By J. B. SCRIVENOR, M.A. (Oxon), F.G.S., Director of the Geological Survey Department, Federated Malay States. Illustrated. 16s. net. (Published with the authority of the Federated Malay States Government.)

"A valuable addition towards the elucidation of Malayan geology, and should prove of considerable assistance to those interested in this country, particularly from a tin-mining point of view."—*Bulletin of the Imperial Institute.*

THE GEOLOGY OF MALAYAN ORE-DEPOSITS. By J. B. SCRIVENOR, M.A., F.G.S. Illustrated. 16s. net.

THE COCONUT. By EDWIN B. COPELAND, Professor of Plant Physiology and Dean of the College of Agriculture (retired), University of the Philippines. *Third Edition, revised.* With Illustrations. 20s. net.

"The book is eminently readable and well illustrated, and will form a valuable addition to the libraries of all who are interested in coconut cultivation."—*The Bulletin of the Imperial Institute* on the First Edition.

CACAO. By DR. C. J. J. VAN HALL, late Director of the Institute for Plant Diseases, Buitenzorg, Java, and late Director of Agriculture in Surinam. *Second Edition, thoroughly revised.* With Illustrations and Map.

RICE. By PROFESSOR EDWIN B. COPELAND. 20s. net.

COTTON AND ITS PRODUCTION. By W. H. JOHNSON. 20s. net.

DISEASES OF THE TEA BUSH. By T. PETCH, B.A., B.Sc. 20s. net.

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HOOKWORM DISEASE: Its Distribution, Biology, Epidemiology, Pathology, Diagnosis, Treatment and Control. By PROFESSOR A. C. CHANDLER. 25s. net.

⁂ *Macmillan's Classified Catalogue, post free on application.*

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

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SHEA NUTS FROM NIGERIA—II

In a previous number of this Bulletin (1930, **28**, 123) a report was published on a series of samples of shea nuts collected in the Kabba and Sokoto Provinces of Nigeria. The object of the investigation was to determine whether any definite varieties of the trees exist in the country, and whether there are any differences in the yield and quality of the fat. The results indicated that further investigation was desirable, and it was suggested that a second series of samples of nuts should be collected from the same trees as the previous series. This second series, consisting of fifteen samples of nuts, was duly forwarded by the Director of Forests, Ibadan, in December 1930, and the results of their examination are given below.

Description

The samples were derived from the following localities :

Kabba Province

AA. From Yagba district, Kabba Division.
BB. From Ajeokuta, Igbirra Division.
CC. From Lokoja-Okeni Road, Igbirra Division.
EE. From Felele, Aworror district, Koton Karifi Division.
FF. From Lokoja Patti.
GG. From Abaji, Koton Karifi Division.

Sokoto Province

Si a.	Sect. III Gusau-Kwiambana Reserve.
Si b.	Sect. I.G. Kwiambana Reserve (Samri).
Sii a.	Zamfara Reserve (Yelwa).
Sii b.	Zamfara Reserve (Tanbri).
Siii a.	Anka No. 3 Reserve.
Siii b.	Anka No. 2 Reserve.
Siv a.	Gulbin Ka Reserve (Gayawa).
Siv b.	Kebbi N.A. Reserve No. 1 (Mararaba).
Sv.	Illela Reserve.

A portion of each sample was submitted to the Director of the Royal Botanic Gardens, Kew, who furnished the following observations regarding them :

" The samples of Shea nuts from the Director of Forests, Nigeria, have been received and an examination of them has been made.

" As stated in the letter of the Director of Forests each sample is the product of one tree.

" The nuts in the samples appeared to be uniformly sound and to have been the product of ripe fruits. It has been found that there is great variation in shape and size among the nuts of any one sample, which is usual with Shea. Taken collectively the samples are all very similar to one another. In certain samples, however—those from Illela Reserve (Sv) ; Gulbin Ka Reserve (Gayawa) (Siv a) ; Kebbi N.A. Reserve No. 1 (Mararaba) (Siv b)—the nuts are on the average smaller than in the other samples, and are marked by an absence of very large nuts.

" From the samples received, variation in the colour of the nuts in some of the samples is noticeable though not pronounced. In the sample forwarded from the Yagba District, Kabba Division (marked AA) the nuts are of a lighter hue than most, while those from the Illela Reserve (Sv) are of a darker, more chocolate colour than the average.

" No other departures from the normal were observed in the shell or kernel, and it is felt that the above variations are insufficient to be of any value but may possibly bear correlation with chemical analysis when these have been carried out."

The general characters of the samples are recorded in the following table :

Sample.	Description of nuts.	Colour of nuts.	Dimensions of nuts in inches.	Internal colour of kernels.	Dimensions of kernels in inches.
KABBA PROVINCE					
AA Yagba.	Rather blunt.	Golden brown.	$1\frac{1}{8} \times \frac{7}{8}$ to $1\frac{3}{4} \times 1\frac{1}{8}$. Mostly $1\frac{1}{4}$ to $1\frac{1}{2} \times 1$ to $1\frac{1}{4}$.	Pinkish brown ; few covered with black mould.	$1 \times \frac{5}{8}$ to $1\frac{1}{2} \times \frac{3}{4}$. Mostly $1\frac{1}{4} \times \frac{3}{4}$.
BB Ajeokuta Okeni Road.	Longish nuts with a tendency to be pointed.	Brown.	$1\frac{1}{8} \times \frac{7}{8}$ to $2 \times 1\frac{1}{8}$. Mostly $1\frac{1}{2} \times 1\frac{1}{8}$.	Buff or pinkish brown ; few covered with black mould.	$1 \times \frac{5}{8}$ to $1\frac{5}{8} \times \frac{3}{4}$. Mostly $1\frac{3}{8} \times \frac{3}{4}$.
CC Okeni (Lokoja Road).	Longish.	Golden brown.	$1\frac{1}{8} \times \frac{3}{4}$ to $1\frac{3}{4} \times 1\frac{1}{4}$. Mostly $1\frac{1}{4}$ to $1\frac{1}{2} \times 1\frac{1}{8}$.	Buff or pinkish brown ; a few dark brown. Few covered with black mould.	$\frac{7}{8} \times \frac{3}{8}$ to $1\frac{1}{2} \times 1$. Mostly $1\frac{1}{4} \times \frac{3}{4}$.
EE Felele (Aworror Division).	Longish, with tendency to be pointed.	Golden brown to reddish brown.	$1\frac{1}{8} \times \frac{3}{4}$ to $1\frac{7}{8} \times 1\frac{1}{8}$. Mostly $1\frac{1}{2} \times 1$.	Mostly pinkish brown ; some buff. Few covered with black or green mould.	$1 \times \frac{5}{8}$ to $1\frac{1}{2} \times \frac{3}{4}$. Mostly $1\frac{3}{8} \times \frac{3}{4}$.
FF Patti Lokoja.	Rather blunt.	Golden brown to brown.	$1\frac{1}{8} \times \frac{7}{8}$ to $1\frac{7}{8} \times 1\frac{1}{4}$. Mostly $1\frac{3}{8} \times 1\frac{1}{8}$.	Mostly pinkish brown ; few dark brown. Few covered with black mould.	$\frac{7}{8} \times \frac{1}{2}$ to $1\frac{5}{8} \times \frac{7}{8}$. Mostly $1\frac{1}{8} \times \frac{3}{4}$.
GG Abaji . . .	—	Golden brown ; few pinkish grey.	$1\frac{1}{8} \times \frac{3}{4}$ to $1\frac{5}{8} \times 1\frac{1}{8}$. Mostly $1\frac{3}{8} \times 1\frac{1}{8}$.	Pinkish brown ; many dark brown. Many covered with black mould.	$1 \times \frac{1}{2}$ to $1\frac{3}{8} \times \frac{7}{8}$. Mostly $1\frac{1}{8} \times \frac{3}{4}$.

Sample.	Description of nuts.	Colour of nuts.	Dimensions of nuts in inches.	Internal colour of kernels.	Dimensions of kernels in inches.
SOKOTO PROVINCE					
Si a . . .	Some blunt; others pointed.	Yellowish brown or golden brown.	$1 \times \frac{3}{4}$ to $1\frac{7}{8} \times 1\frac{1}{8}$. Mostly $1\frac{1}{2} \times 1\frac{1}{8}$.	Pinkish brown, many dark brown. Many covered with black mould.	$\frac{7}{8} \times \frac{1}{2}$ to $1\frac{3}{8} \times \frac{3}{4}$. Mostly $1\frac{1}{4} \times \frac{3}{4}$.
Si b . . .	Rather variable size. Blunt.	Yellowish brown to brown.	$1 \times \frac{3}{4}$ to $1\frac{3}{4} \times 1\frac{1}{2}$. Mostly $1\frac{1}{4} \times 1$ and $1\frac{1}{2} \times 1\frac{1}{4}$.	Pinkish brown, buff or dark brown. Some covered with black mould.	$\frac{7}{8} \times \frac{3}{8}$ to $1\frac{1}{2} \times \frac{3}{4}$. Mostly $1\frac{1}{8} \times \frac{5}{8}$ and $1\frac{1}{4} \times \frac{7}{8}$.
Sii a . . .	Rather variable size. Pointed.	Brown. Some pinkish brown.	$1 \times \frac{5}{8}$ to $1\frac{3}{4} \times 1\frac{1}{4}$. Mostly $1\frac{3}{8} \times 1$.	Pinkish brown; many dark brown. Many covered with black mould.	$\frac{3}{4} \times \frac{3}{8}$ to $1\frac{1}{2} \times \frac{3}{4}$. Mostly $1\frac{1}{4} \times \frac{5}{8}$.
Sii b . . .	Blunt.	Brown to pinkish brown.	$1 \times \frac{3}{4}$ to $1\frac{3}{4} \times 1\frac{1}{4}$. Mostly $1\frac{1}{2} \times 1\frac{1}{8}$.	Pinkish brown; some dark brown. Some covered with green mould.	$\frac{3}{4} \times \frac{1}{2}$ to $1\frac{1}{2} \times \frac{3}{4}$. Mostly $1\frac{1}{4} \times \frac{3}{4}$.
Siii a . . .	Rather smaller than any of above samples. Blunt or pointed.	Orange brown to brown. Few pinkish brown.	$\frac{7}{8} \times \frac{3}{4}$ to $1\frac{7}{8} \times 1\frac{1}{4}$. Mostly $1\frac{1}{4} \times \frac{7}{8}$.	Pinkish brown; some dark brown. Many covered with black or green mould.	$\frac{3}{4} \times \frac{1}{2}$ to $1\frac{1}{2} \times \frac{3}{4}$. Mostly $1\frac{1}{8} \times \frac{5}{8}$.
Siii b . . .	Variable in size. Blunt or pointed.	Golden brown.	$1 \times \frac{3}{4}$ to $1\frac{7}{8} \times 1\frac{1}{4}$. Mostly $1\frac{1}{4} \times 1$.	Pinkish brown.	$\frac{7}{8} \times \frac{1}{2}$ to $1\frac{5}{8} \times \frac{7}{8}$. Mostly $1 \times \frac{3}{4}$.
Siv a . . .	Blunt.	Golden brown to brown.	$1\frac{1}{8} \times \frac{7}{8}$ to $1\frac{1}{2} \times 1\frac{1}{8}$. Mostly $1\frac{3}{8} \times 1$.	Pinkish brown. Very many covered with black or green mould.	$1 \times \frac{5}{8}$ to $1\frac{1}{4} \times \frac{3}{4}$. Mostly $1\frac{1}{8}$ to $1\frac{1}{4} \times \frac{3}{4}$.
Siv b . . .	Pointed or blunt.	Golden brown to brown.	$1 \times \frac{7}{8}$ to $1\frac{5}{8} \times 1\frac{1}{8}$. Mostly $1\frac{3}{8} \times 1$.	Pinkish brown. Few covered with black or green mould.	$\frac{3}{4} \times \frac{5}{8}$ to $1\frac{1}{2} \times \frac{7}{8}$. Mostly $1\frac{1}{8} \times \frac{3}{4}$.
Sv . . .	Pointed or blunt.	Dull. Brown.	$1 \times \frac{5}{8}$ to $1\frac{1}{2} \times 1\frac{1}{8}$. Mostly $1\frac{3}{8} \times 1$.	Pinkish brown. Rather poorly developed. Many covered with black mould.	$\frac{3}{4} \times \frac{3}{8}$ to $1\frac{1}{4} \times \frac{3}{4}$. Mostly 1 to $1\frac{1}{8} \times \frac{5}{8}$.

TABLE I

KABBA PROVINCE.	Yagba AA.		Ajeokuta BB.		Lokoja Road CC.		Felele EE.		Lokoja Patti Reserve FF.		Abaji GG.	
	1930.	1928.	1930.	1928.	1930.	1928.	1930.	1928.	1930.	1928.	1930.	1928.
Average weight of nuts, grams	8·7	8·4	9·1	8·7	8·4	8·4	8·7	7·7	9·1	9·1	7·9	—
Average weight of kernels, grams	5·9	6·0	5·9	7·4	5·5	5·7	6·0	4·7	5·6	6·2	4·8	—
Kernel in nuts, per cent	67·5	71·2	65·0	84·5	65·5	67·3	69·0	61·3	61·5	68·5	60·5	—
Shell in nuts, per cent.	32·5	28·8	35·0	15·5	34·5	32·7	31·0	38·7	38·5	31·5	39·5	—

TABLE I (*continued*)

SOKOTO PROVINCE.	Si a.		Si b.		Sii a.		Sii b.		Siii a.		Siii b.		Siv a.		Siv b.		Sv.	
	1930.	1928.	1930.	1928.	1930.	1928.	1930.	1928.	1930.	1928.	1930.	1928.	1930.	1928.	1930.	1928.	1930.	1928.
Average weight of nuts, grams.	7·6	—	7·7	10·0	6·3	6·4	6·8	5·9	5·7	6·5	6·6	7·2	6·1	4·9	5·9	4·1	5·0	4·9
Average weight of kernels, grams	5·3	—	5·3	7·0	3·8	4·3	4·1	4·4	3·7	4·2	4·8	4·2	4·3	3·5	4·2	2·9	2·8	3·1
Kernel in nuts, per cent.	69·5	—	68·5	70·0	60·5	66·5	60·0	75·5	65·5	65·0	72·5	57·6	71·0	72·0	71·5	70·0	56·5	63·0
Shell in nuts, per cent.	30·5	—	31·5	30·0	39·5	33·5	40·0	24·5	34·5	35·0	27·5	42·4	29·0	28·0	28·5	30·0	43·5	37·0

TABLE II

KABBA PROVINCE.	Yagba AA.		Ajeokuta BB.		Lokoja Road CC.		Felele EE.		Lokoja Patti Reserve FF.		Abaji GG.	
	1930.	1928.	1930.	1928.	1930.	1928.	1930.	1928.	1930.	1928.	1930.	1928.
Moisture in kernels, per cent.	6·2	12·1	6·0	6·4	6·0	6·5	6·0	7·4	5·8	6·3	5·7	—
Oil in kernels, as received, per cent. . . .	43·4	35·6	42·0	41·4	43·2	39·1	43·9	35·9	46·3	38·7	46·0	—
Oil in moisture-free kernels, per cent. . . .	46·3	40·5	44·7	44·2	46·0	41·8	46·7	38·8	49·2	41·3	48·8	—
Oil in nuts, per cent.	29·3	25·3	27·3	35·0	28·3	26·3	30·3	22·0	28·5	26·5	27·8	—
Unsaponifiable matter in oil, per cent. . . .	8·2	9·2	10·0	7·7	7·5	9·4	11·4	11·8	7·6	8·6	8·1	—

TABLE II (*continued*)

SOKOTO PROVINCE.	Si a.		Si b.		Sii a.		Sii b.		Siii a.		Siii b.		Siv a.		Siv b.		Sv.	
	1930.	1928.	1930.	1928.	1930.	1928	1930.	1928.	1930.	1928.	1930.	1928.	1930.	1928.	1930.	1928.	1930.	1928.
Moisture in kernels, per cent..	5·9	—	5·8	6·0	6·7	6·2	7·9	5·2	6·7	6·3	6·3	7·1	5·5	5·2	5·8	5·2	7·2	6·4
Oil in kernels as received, per cent.	44·3	—	45·1	40·3	34·3	39·5	27·0	45·9	37·7	40·3	39·4	31·5	46·0	47·6	43·1	46·3	35·1	35·1
Oil in moisture-free kernels, per cent.	47·1	—	47·9	42·9	36·8	42·1	29·3	48·4	40·4	43·0	42·1	33·9	48·7	50·2	45·8	48·8	37·8	37·5
Oil in nuts, per cent. . .	30·8	—	30·9	28·2	20·8	26·3	16·2	34·7	24·7	26·2	28·6	18·1	32·7	34·3	30·8	32·4	19·8	22·1
Unsaponifiable matter in oil, per cent.	8·0	—	7·1	7·1	10·2	6·3	16·6	5·1	8·6	7·8	7·9	11·0	6·3	6·1	6·9	5·7	13·1	10·1

RESULTS OF EXAMINATION

The samples were submitted to detailed examination, and the results are recorded in Tables I to VII.

Tables I and II give the results of determinations of the relative weights and composition of the nuts, the amounts of oil which they contained and the percentages of unsaponifiable matter in the oils. Tables III to VI show the correlation of the unsaponifiable matter with other factors, and Table VII gives a comparison of the percentage of unsaponifiable matter in the oil from the samples received in 1928 and from the present series (1930).

TABLE III

RELATION OF PERCENTAGE OF KERNELS IN NUTS TO PERCENTAGE OF OIL (EXPRESSED ON KERNELS AS RECEIVED AND ON MOISTURE-FREE KERNELS) AND TO PERCENTAGE OF UNSAPONIFIABLE MATTER IN OIL.

(1930 SAMPLES)

Sample.	Kernels in nuts.	Oil in kernels as received.	Oil in moisture-free kernels.	Unsaponifiable matter in oil.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Siii b	72·5	39·4	42·1	7·9
Siv b	71·5	43·1	45·8	6·9
Siv a	71·0	46·0	48·7	6·3
Si a	69·5	44·3	47·1	8·0
EE	69·0	43·9	46·7	11·4
Si b	68·5	45·1	47·9	7·1
AA	67·5	43·4	46·3	8·2
Siii a	65·5	37·7	40·4	8·6
CC	65·5	43·2	46·0	7·5
BB	65·0	42·0	44·7	10·0
FF	61·5	46·3	49·2	7·6
Sii a	60·5	34·3	36·8	10·2
GG	60·5	46·0	48·8	8·1
Sii b	60·0	27·0	29·3	16·6
Sv	56·5	35·1	37·8	13·1

TABLE IV

RELATION OF PERCENTAGE OF OIL IN MOISTURE-FREE KERNELS TO PERCENTAGE OF UNSAPONIFIABLE MATTER IN OIL

(1930 SAMPLES)

Sample.	Oil in moisture-free kernels.	Unsaponifiable matter in oil.	Sample.	Oil in moisture-free kernels.	Unsaponifiable matter in oil.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
FF	49·2	7·6	Siv b	45·8	6·9
GG	48·8	8·1	BB	44·7	10·0
Siv a	48·7	6·3	Siii b	42·1	7·9
Si b	47·9	7·1	Siii a	40·4	8·6
Si a	47·1	8·0	Sv	37·8	13·1
EE	46·7	11·4	Sii a	36·8	10·2
AA	46·3	8·2	Sii b	29·3	16·6
CC	46·0	7·5			

TABLE V

Relation of Percentage of Oil in Entire Nuts to Percentage of Unsaponifiable Matter in Oil

(1930 Samples)

Sample.	Oil in entire nuts.	Unsaponifiable matter in oil.	Sample.	Oil in entire nuts.	Unsaponifiable matter in oil.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Siv a	32·7	6·3	CC	28·3	7·5
Si b	30·9	7·1	GG	27·8	8·1
Siv b	30·8	6·9	BB	27·3	10·0
Si a	30·8	8·0	Siii a	24·7	8·6
EE	30·3	11·4	Sii a	20·8	10·2
AA	29·3	8·2	Sv	19·8	13·1
Siii b	28·6	7·9	Sii b	16·2	16·6
FF	28·5	7·6			

TABLE VI

Relation of Weight of Kernel to Percentage of Unsaponifiable Matter in Oil

(1930 Samples)

Sample.	Average weight of kernel.	Unsaponifiable matter in oil.	Sample.	Average weight of kernel.	Unsaponifiable matter in oil.
	Grams.	*Per cent.*		*Grams.*	*Per cent.*
EE	6·0	11·4	Siii b	4·8	7·9
AA	5·9	8·2	Siv a	4·3	6·3
BB	5·9	10·0	Siv b	4·2	6·9
FF	5·6	7·6	Sii b	4·1	16·6
CC	5·5	7·5	Sii a	3·8	10·2
Si a	5·3	8·0	Siii a	3·7	8·6
Si b	5·3	7·1	Sv	2·8	13·1
GG	4·8	8·1			

TABLE VII

Comparison of Percentages of Unsaponifiable Matter in the Oil from the 1928 and 1930 Samples

Sample.	1928.	1930.	Sample.	1928.	1930.
Sii b	5·1	16·6	F	8·6	7·6
Siv b	5·7	6·9	A	9·2	8·2
Siv a	6·1	6·3	C	9·4	7·5
Sii a	6·3	10·2	Sv	10·1	13·1
Si b	7·1	7·1	Siii b	11·0	7·9
B	7·7	10·0	E	11·8	11·4
Siii a	7·8	8·6			

Comparison of the Present Samples with those forwarded in 1928

The results of the examination show that in many cases the present samples differ from the corresponding samples forwarded in 1928. These differences, which may be due to seasonal variation or to dissimilar states of maturity of the nuts in the two series, are summarised in the following paragraphs :

Kabba Province

Yagba. The kernels of the present sample yield more oil, which contains less unsaponifiable matter.

Ajeokuta. The present nuts contain a smaller percentage of kernel. The kernels are smaller and yield about the same amount of oil, which, however, contains more unsaponifiable matter.

Lokoja Road. The kernels of the present sample yield more oil, which contains less unsaponifiable matter.

Felele. The nuts of the present sample yield a higher percentage of kernel. The kernels are larger and contain more oil, the amount of unsaponifiable matter in which is slightly lower than that in the previous sample.

Lokoja Patti Reserve. The nuts of the present sample contain a lower percentage of kernel. The kernels are slightly smaller and yield more oil, which contains less unsaponifiable matter.

Abaja. No corresponding sample was received in 1928.

Sokoto Province

Si a. No corresponding sample was received in 1928.

Si b. The nuts of the present sample, though smaller, have a similar composition to those received in 1928. The kernels are smaller and yield more oil, which contains the same amount of unsaponifiable matter.

Sii a. The present nuts contain a lower percentage of kernel. The kernels are smaller and yield less oil, which contains much more unsaponifiable matter.

Sii b. The nuts of the present sample are larger but contain a lower percentage of kernel. The kernels yield much less oil, which contains much more unsaponifiable matter. There is a very marked difference, therefore, between the 1930 and the 1928 sample.

Siii a. The kernels of the present sample are slightly smaller and yield slightly less oil, which contains more unsaponifiable matter.

Siii b. The present nuts, though smaller, contain a higher percentage of kernel. The kernels are larger and yield more oil, which contains considerably less unsaponifiable matter.

Siv a. The nuts and kernels of the present sample are larger, but otherwise the 1930 and 1928 samples are very similar.

Siv b. The present nuts and kernels are larger. The kernels yield slightly less oil which contains more unsaponifiable matter.

Sv. The nuts of the present sample contain a lower percentage of kernel. The kernels are smaller and not so well developed. They yield a similar amount of oil, which contains more unsaponifiable matter.

REMARKS

It will be seen from Tables I and II that the samples from each province (Kabba and Sokoto) show considerable variations among themselves with regard to (1) the percentages of kernel and shell in the nuts, (2) the percentage of oil in the moisture-free kernels, and (3) the percentage of unsaponifiable matter in the oil. The results may be summarised as follows :

Percentages of Kernel and Shell

Kabba samples. The figures range from 60·5 per cent. kernel and 39·5 per cent. shell to 69 per cent. kernel and 31 per cent. shell. The present samples do not show such a great variation in this respect as did the previous series.

Sokoto samples. The figures vary from 56·5 per cent. kernel and 43·5 per cent. shell to 72·5 per cent. kernel and 27·5 per cent. shell. The range is very similar to that for the 1928 samples.

Oil in Moisture-free Kernels

Kabba samples. From 44·7 to 49·2 per cent. of oil, with an average of 47 per cent. The variation is less than in the 1928 samples while the average is considerably higher.

Sokoto samples. From 29·3 per cent. to 48·7 per cent. of oil, with an average of 41·8 per cent. The present samples show a similar variation to those of 1928 while the average is slightly lower.

Unsaponifiable Matter in Oil

Kabba samples. From 7·5 to 11·4 per cent., with an average of 8·8 per cent. The present samples show a range similar to that shown by the 1928 samples while the average is about 1 per cent. lower.

Sokoto samples. From 6·3 to 16·6 per cent., with an average of 9·4 per cent. The present samples show a wider variation than those of the previous series while the average is 2 per cent. higher.

Comparison of Kabba samples with Sokoto samples

Comparing the results for the two groups of the present series, it will be seen that on the average the Kabba samples give a higher yield of oil and a slightly lower percentage of unsaponifiable matter than the samples from Sokoto. These results are the direct opposite of those obtained in 1928, but are in agreement with the findings of Greenwood (*Ann. Rep. Dept. Agric., Nigeria*, 1928). The kernels of all the Kabba samples, with the exception of Abaji, are heavier than those of the Sokoto samples.

A study of Tables III to VI will show that the results of the examination of the present series of samples tend to confirm the following provisional conclusions of the previous report :

(*a*) Some connection seems to exist between the amount of unsaponifiable matter and the percentage of kernel in the nut. The lower the percentage of kernel, the higher the percentage of unsaponifiable matter (Table III). This relation is not quite so marked in the present series.

(*b*) There appears to be some relationship between the amount of unsaponifiable matter and the percentage of oil in the moisture-free kernels. The lower the oil content, the higher is the percentage of the unsaponifiable constituent (Table IV).

The same general conclusion is indicated in Table V, where the amount of unsaponifiable matter is compared with the percentage of oil in the entire nuts.

(*c*) It would therefore seem that the riper the nuts, the lower the amount of unsaponifiable matter in the extracted oil.

(*d*) The average weight of the kernel does not appear to bear any relationship to the percentage of unsaponifiable matter in the oil (Table VI).

There does not appear to be any connection between the shape or colour of the nuts and the amount of unsaponifiable matter in the oil.

Sample Siii b from Anka Reserve No. 2 in 1928 was the only one showing any noticeable botanical variation. The kernels of this sample yielded the lowest percentage of oil while the oil contained a high percentage of unsaponifiable matter. The corresponding 1930 sample yielded more oil, which contained considerably less unsaponifiable matter.

The results also show that the oils obtained from different crops of kernels from the same tree or area do not as a rule contain a constant amount of unsaponifiable matter. It follows from this that although in a particular year a crop of kernels from a definite area might yield an oil containing a low percentage of unsaponifiable matter, this feature might not characterise the crop of the following year.

APPENDIX

Comparison of determinations of the weight and composition of Shea nuts in Nigeria and at the Imperial Institute.

In the following table the figures obtained in Nigeria as the result of determinations of the average weights of Shea nuts and kernels and the percentages of shell and kernel, which have been communicated to the Imperial Institute by the Director of Forests, are compared with those obtained with the samples of the two series forwarded to the Imperial Institute in 1928 and 1930.

REMARKS

It is assumed that the samples examined in Nigeria were from the same crop as those forwarded to the Imperial Institute in 1930, and the following remarks are therefore confined to these two sets of samples.

—		Nigeria figures.	Imperial Institute figures.	
			1928.	1930.
Yagba AA.				
Average weight of nuts .	. *grams*	9·70	8·4	8·7
Average weight of kernels	. *grams*	6·76	6·0	5·9
Kernels . . .	*per cent.*	69·7	71·2	67·5
Shell	*per cent.*	30·3	28·8	32·5
Ajeokuta BB.				
Average weight of nuts .	. *grams*	9·24	8·7	9·1
Average weight of kernels	. *grams*	5·544	7·4	5·9
Kernels . . .	*per cent.*	59·95	84·5	65·0
Shell	*per cent.*	40·05	15·5	35·0
Lokoja Road CC.				
Average weight of nuts .	. *grams*	8·788	8·4	8·4
Average weight of kernels	. *grams*	5·83	5·7	5·5
Kernels . . .	*per cent.*	66·3	67·3	65·5
Shell	*per cent.*	33·7	32·7	34·5
Felele EE.				
Average weight of nuts .	. *grams*	9·57	7·7	8·7
Average weight of kernels	. *grams*	6·568	4·7	6·0
Kernels . . .	*per cent.*	68·6	61·3	69·0
Shell	*per cent.*	31·4	38·7	31·0
Lokoja Patti Reserve FF.				
Average weight of nuts .	. *grams*	9·969	9·1	9·1
Average weight of kernels	. *grams*	6·607	6·2	5·6
Kernels . . .	*per cent.*	66·3	68·5	61·5
Shell	*per cent.*	33·7	31·5	38·5
Abaji GG.				
Average weight of nuts .	. *grams*	8·791	—	7·9
Average weight of kernels	. *grams*	5·618	—	4·8
Kernels . . .	*per cent.*	63·9	—	60·5
Shell	*per cent.*	36·1	—	39·5
Si b.				
Average weight of nuts .	. *grams*	8·77	10·0	7·7
Average weight of kernels	. *grams*	5·94	7·0	5·3
Kernels . . .	*per cent.*	67·7	70·0	68·5
Shell	*per cent.*	32·3	30·0	31·5
Sii a.				
Average weight of nuts .	. *grams*	9·4253	6·4	6·3
Average weight of kernels	. *grams*	6·662	4·3	3·8
Kernels . . .	*per cent.*	70·67	66·5	60·5
Shell	*per cent.*	29·33	33·5	39·5
Sii b.				
Average weight of nuts .	. *grams*	12·407	5·9	6·8
Average weight of kernels	. *grams*	9·378	4·4	4·1
Kernels . . .	*per cent.*	75·38	75·5	60·0
Shell	*per cent.*	24·62	24·5	40·0
Siii a.				
Average weight of nuts .	. *grams*	6·292	6·5	5·7
Average weight of kernels	. *grams*	4·152	4·2	3·7
Kernels . . .	*per cent.*	65·94	65·0	65·5
Shell	*per cent.*	34·06	35·0	34·5
Siii b.				
Average weight of nuts .	. *grams*	7·824	7·2	6·6
Average weight of kernels	. *grams*	5·747	4·2	4·8
Kernels . . .	*per cent.*	73·46	57·6	72·5
Shell	*per cent.*	26·54	42·4	27·5
Siv a.				
Average weight of nuts .	. *grams*	5·869	4·9	6·1
Average weight of kernels	. *grams*	3·965	3·5	4·3
Kernels . . .	*per cent.*	67·53	72·0	71·0
Shell	*per cent.*	32·47	28·0	29·0
Siv b.				
Average weight of nuts .	. *grams*	6·619	4·1	5·9
Average weight of kernels	. *grams*	4·623	2·9	4·2
Kernels . . .	*per cent.*	69·85	70·0	71·5
Shell	*per cent.*	30·15	30·0	28·5
Sv.				
Average weight of nuts .	. *grams*	7·751	4·9	5·0
Average weight of kernels	. *grams*	5·135	3·1	2·8
Kernels . . .	*per cent.*	66·24	63·0	56·5
Shell	*per cent.*	33·76	37·0	43·5

It will be seen from the table that, after making allowances for slight differences in sampling and for drying during transit, the Nigerian figures are in the main similar to those obtained at the Imperial Institute. The most marked differences are those in respect of samples Sii a, Sii b and Sv, the nuts examined in Nigeria being considerably heavier than those received at the Imperial Institute.

The Nigerian figures confirm the observations made at the Imperial Institute as to the wide variations that exist with respect to size, weight and composition of Shea nuts from different localities. The range found for the kernel percentage in samples of the Sokoto series was, however, less than that observed at the Imperial Institute. The figures also show that considerable variations occur in the weights and composition of different sizes of nuts graded from the same sample.

TANNING MATERIALS

1. Quebracho from St. Lucia

The samples which are the subject of this report were forwarded to the Imperial Institute by the Agricultural Superintendent in St. Lucia in February 1931. They were submitted in accordance with a request by the Advisory Committee on Tanning Materials of the Imperial Institute, who had been considering the cultivation of Quebracho trees within the Empire and considered that it would be of interest to ascertain the age at which the trees could be economically felled in relation to their tannin content.

The samples were forwarded as representing portions of the trunk and branches of a thirteen-year-old Quebracho tree growing at the Réunion Experiment Station. Botanical specimens from the plantation had been forwarded in 1928 to the Royal Botanic Gardens, Kew, and identified there as *Schinopsis Lorentzii.*

The samples consisted of five logs, varying from 8 lb. to 16½ lb. in weight. They were covered with bark which was about ⅛ in. thick, fairly smooth and greyish brown externally, and dark reddish brown on the inner surface. The sapwood was buff-coloured and the heartwood pale reddish brown. The logs had the following dimensions :

Log.	Length.	Diameter.	Diameter of Heartwood.
	Inches.	*Inches.*	*Inches.*
No. 1 (Base of trunk) . . .	14	6	3
„ 2A (Main branch) . . .	20	4	about 1
„ 2B (Main branch) . . .	21	4¼	about 1
„ 3 (Middle of trunk) . .	19	5¼	about 1½
„ 5 (Upper trunk) . . .	15	4¾	about 1½

For the purpose of comparison the Imperial Institute obtained a commercial sample of Argentine quebracho, consisting of a log of dark reddish-brown heartwood, 16 in. long and 10½ to 11½ in. in diameter.

Samples No. 1, 2B and 5, which were selected for detailed examination, were found to contain the following amounts of bark, sapwood and heartwood :

	No. 1 (Trunk).	No. 2B (Branch).	No. 5 (Trunk).
	Per cent.	*Per cent.*	*Per cent.*
Bark . . .	9·0	9·3	10·3
Sapwood . .	80·5	83·4	74·1 [1]
Heartwood . .	10·5	7·3	15·6 [1]

[1] *No sharp separation of heartwood and sapwood could be perceived in this sample and the figures must therefore be regarded as approximate.*

The bark, sapwood and heartwood of these three samples, and the Argentine heartwood used for comparison, were analysed with the results shown in table on page 422.

Heartwood.—The foregoing results show that the heartwood taken from the base of the tree (Sample 1) contained about the same amount of tannin as Sample 2B representing the heartwood from a portion of the main branch, and that the amount was only half that present in the commercial sample of Argentine quebracho heartwood used for comparison. The low amount of tannin in Sample 5, from the upper portion of the trunk, may perhaps be attributable to the difficulty in this instance in distinguishing clearly between the heartwood and sapwood.

It will be seen that these heartwoods from different parts of the tree all gave rather darker-coloured extracts

	No. 1 (Trunk).			No. 2B (Branch).			No. 5 (Trunk).			Argentine quebracho (heartwood)
	Bark.	Sapwood.	Heartwood.	Bark.	Sapwood.	Heartwood.	Bark.	Sapwood.	Heart-wood.[3]	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	15·0	9·4	13·3	16·3	9·0	14·0	17·0	9·7	11·6	13·2
Insoluble matter	68·4	85·2	73·7	67·0	86·9	72·5	66·0	84·7	77·5	66·2
Extractive matter (non-tannin)	8·2	3·8	3·6	9·5	3·5	4·5	9·7	4·0	4·0	2·2
Tannin[1]	8·4	1·6	9·4	7·2	0·6	9·0	7·3	1·6	6·9	18·4
Ash	5·5	0·8	1·3	4·0	0·7	1·1	4·6	0·8	1·1	0·6
Tintometer readings:[2]										
Red	28·2	13·1	5·1	30·3	20·3	5·3	27·2	8·8	4·5	3·4
Yellow	62·2	50·0	9·6	82·1	80·0	10·3	102·6	40·6	8·3	6·1

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[1] *Carried out by the Official International Method of Tannin Analysis, except that in the case of St. Lucia samples the Procter extractor was used in place of the Koch (Hide Powder Batch C.3).*

[2] *Determined for a solution containing 0·5 per cent. of tannin in a 1 centimetre cell.*

[3] *As no sharp separation of heartwood and sapwood could be perceived in sample No. 5, these figures for heartwood must be regarded as mere approximations.*

NOTE—*Samples 2A and 3 were not examined. These were from intermediate positions on the tree, and in view of the above results obtained with Nos. 1, 2B and 5, their analysis was not considered necessary.*

than the sample of Argentine quebracho wood used for comparison.

Sapwood.—The amounts of tannin in the sapwood of the present samples correspond to those stated to be found in the sapwood of Argentine quebracho, viz. 0 to 4 per cent.

Bark.—The barks from the present samples gave very highly coloured extracts, containing large proportions of soluble non-tannin matter. They contained, however, slightly more tannin than the figures (viz. 5 to 6 per cent.) recorded for the inner bark of quebracho trees over forty years old, the outer bark of which is stated to contain about 2 per cent. of tannin.

It is generally accepted that a quebracho tree is not suitable for cutting until it is forty years of age, and the results of examination of the present samples from a thirteen-year-old tree show that the heartwood (the part of the quebracho tree usually employed) contains only about half the amount of tannin found in the commercial material. This point is of importance as no data are on record for the tannin content of quebracho trees in correlation with age. It is clear from the present results that to cut the trees for commercial purposes when only thirteen years old would not be a profitable enterprise in competition with the Argentine industry.

An investigation of logs cut from trees of different ages with a view to determining the tannin content at various stages of growth, and the point at which it reaches a maximum, would be of much interest and might furnish valuable results.

2. Kamachile Extract from North Borneo

Kamachile is the Philippine name for *Pithecolobium dulce* (natural order Leguminosæ), an evergreen tree, reaching a height of 50 ft. or more. The tree is native to Mexico, but is now cultivated in Central America, Colombia, Philippine Islands, India, Ceylon, and many other countries of the tropics, in some of which it has now become naturalised. It is commonly planted as an ornamental tree and as a hedge-plant. It possesses thorny stipules and is known in India as Madras thorn.

Standley ("Trees and Shrubs of Mexico," *Contributions from the United States National Herbarium*, Vol. xxiii, 1920–26, p. 393) states that "the wood is widely employed for general construction purposes, for fence posts, and for fuel. The bark yields a yellow dye, and is much used for tanning skins; it is used in domestic medicine also, because of its astringent properties. The gum exuding from the trunk is transparent and deep reddish brown; dissolved in water it makes good mucilage. The flowers are much frequented by bees and yield a good quality of honey. The fruit is highly esteemed in Mexico and is a common article in the markets. The acidulous aril surrounding the seeds is eaten and is used in the preparation of a beverage similar to lemonade. Stock of all kinds are fond of the pods."

The pulp surrounding the seed was found by Kesava-Menon (*Journ. Soc. Chem. Indust.*, Vol. xxix, No. 24, 1910, p. 1431) to contain 18·2 per cent. of a yellowish-white oil which solidified at a temperature of 15° C. (equivalent to 13·2 per cent. calculated on the whole seed).

According to T. H. Norton ("Tanning Materials of Latin America," *Special Agents Series No.* 165, *U.S. Bur. of For. and Dom. Comm.*, 1918), the bark is extensively used in Jalisco and Morelos, Mexico, for tanning saddle and harness leather.

The tree was introduced into the Philippine Islands by the Spaniards many years ago and the bark is now the chief tanning material used by the Filipinos. V. Q. Gana ("The Leather Industry of the Philippine Islands," *Philippine Journ. Sci.*, A., Vol. x, No. 6, Nov. 1915), states that the tree is widely scattered throughout the Islands, although nowhere systematically or extensively grown. The annual consumption of the bark, at the time Gana's paper was written, amounted to about 1,500 tons, but the supply was at that time threatened with exhaustion as the trees were commonly killed by too extensive stripping of the bark. According to Gana the bark produces dull but light-coloured leather, which reddens on exposure to light; a representative sample of the Philippine bark contained 25·36 per cent. of tannin and 9·41 per cent. of non-tannin extractive matter, expressed on water-free material. An infusion of the bark readily ferments and decomposes in a tropical climate, but this can be prevented by the addition of antiseptics, such as 0·1 per cent. of phenol. Gana mentions that the bark contains irritating principles "which are believed by labourers in the tanneries to indicate roughly the strength of infusions. Infection of the eyes, producing weakening of the sight, and irritation and swelling of the lids are attributed to them."

The bark does not appear to have been used hitherto as a source of tanning extract, and with a view to ascertaining its suitability for this purpose a sample of cutch was prepared and sent to the Imperial Institute by the Acting Conservator of Forests, North Borneo, for examination. According to information furnished by the Acting Conservator of Forests, Pithecolobium was introduced into North Borneo some years ago as a shade and ornamental tree. It grows well in the Territory, and is an excellent reafforestation crop on abandoned shifting cultivation areas which have become covered with Lalang grass (*Imperata cylindrica* and *I. exaltata*). From the information so far available it appears that the bark may be harvested in about ten years from the date of planting. The tree coppices well and the wood is useful for firewood and possibly for also wood-pulp.

The material received at the Imperial Institute consisted of an irregular piece of almost black, solid extract. It was analysed with the following results:

	Per cent.
Moisture	24·2
Insoluble matter	0·9
Extractive matter (non-tannin)	23·5
Tannin[1]	51·4
Ash	7·9
Tintometer readings[2]	
Red	10·5
Yellow	21·9

[1] *Analysis made by the Official International Method of Tannin Analysis (Hide Powder Batch C.*3).

[2] *Determined for a solution containing* 0·5 *per cent. tannin in a* 1 *centimetre cell.*

The material furnished a fairly soft leather, pale brown in colour with a slight pinkish tint, and of firm texture and fine grain.

The results of examination indicate that the present extract has been well prepared, and contains only a very small amount of insoluble matter. For an extract containing 24 per cent. of water the amount of tannin present may be considered high, and the composition of the material generally satisfactory. The tintometer readings are, however, rather high, and although the leather produced was of lighter colour than would be expected from these figures, it had a slight pinkish tint and was not so pale or generally satisfactory in colour as the leather obtained with wattle and certain other commercial extracts.

In view of the excellent composition of this extract, its possible production for shipment is worth further consideration if it appears likely that it could be regularly offered in commercial quantities at a price enabling it to compete with extracts already on the market. At the present time (September 1931), when current prices in the United Kingdom are rather low, wattle extract containing 60 per cent. of tannin is realising £18 12*s*. 6*d*. per ton c.i.f. in London, and quebracho soluble solid extract containing 65 per cent. of tannin, £18 12*s*. 6*d*. to £19 2*s*. 6*d*. per ton.

The North Borneo authorities have been informed that it would be of interest if observations regarding the feasibility of manufacturing the extract on a commercial scale for export could be furnished for consideration by the Imperial Institute Advisory Committee on Tanning Materials, with a view to deciding on the possibility of finding an outlet for the material in the United Kingdom.

3. Tanekaha Bark from New Zealand

A sample of Tanekaha bark, taken from a parcel which had been sent from New Zealand for sale, was forwarded for analysis to the Imperial Institute by the High Commissioner in October 1931.

This bark, the product of *Phyllocladus trichomanoides*, a Gymnosperm, was formerly shipped to Europe for use in the French gloving leather industry. It was not used as a tanstuff proper, but rather for its tinctorial properties.

Supplies had not been regular, however, and the demand in France ceased. There appears to be little or no demand for the bark at the present time in New Zealand.

According to Cheeseman's *Manual of the New Zealand Flora*, the tree, which is known locally also as Toatoa and Celery-topped Pine, occurs in North Island in forests from the North Cape to Taranaki and Hawke's Bay, and in South Island in the northern portions of Nelson and Marlborough, advancing along the west coast as far as Westport. It is understood that the best stands occur between Rotorua and the Bay of Plenty (latitude 38° S.), It grows at all elevations from sea-level to 2,000 ft., but appears to thrive best at an altitude of about 1,500 ft. In favourable localities the tree makes rapid growth, but not comparable with that of exotic pines.

The sample received at the Imperial Institute consisted of two pieces of bark, one being 6 in. × 6 in. × ½ in. and the other 5 in. × 6 in. × ½ in. The outer surface of the bark was rough and dark reddish brown, and the inner surface was fibrous and of a yellowish-brown colour.

The bark was submitted to examination with the following results :

	Per cent.
Moisture	13·2
Insoluble matter	59·7
Extractive matter (non-tannin)	6·3
Tannin[1]	20·8
Ash	2·5
Tintometer readings :[2]	
Red	11·4
Yellow	22·8

[1] *Analysis made by the Official International Method of Tannin Analysis (Hide Powder Batch C.*3).

[2] *Determined for a solution containing* 0·5 *per cent. tannin in a* 1 *centimetre cell.*

Previous analyses show a considerable variation in the tannin content of Tanekaha bark. Procter (*The Principles of Leather Manufacture*, 1922, p. 284) states that the bark contains 28–30 per cent. of tannin, whilst Aston (" The Indigenous Tans and Vegetable Dyestuffs of New Zealand, Part II," *New Zeal. Journ. Agric.*, Vol. xvi, No. 6, June 1918, p. 361) records the following figures :

	Moisture. *Per cent.*	Tannin. *Per cent.*	Non-Tans. *Per cent.*
1	10	19·1	14·2
2	10	11·8	10·5
3	10	11·6	8·8
4	15	9·7	6·1

Sample No. 1 was the outer bark of a very old tree from Mamaku, Rotorua (altitude 1,750 ft.); No. 2 was the inner bark of a very old tree from the same locality; and Nos. 3 and 4 were collected on sandhills at sea-level at Westhaven, Collingwood.

Mr. P. White, Leather Research Chemist, Department of Scientific and Industrial Research, New Zealand, in his article on the tanning materials of New Zealand, published in this BULLETIN (1930, **28**, 450), states that an earlier investigator describes the bark as containing 23–28 per cent. of tannin, but that later investigations have shown 17 per cent. of tannin and 9·2 per cent. of non-tannins (expressed on material containing 10 per cent. of moisture). He mentions that the age of the tree is an important factor as far as the tannin content of the bark is concerned and that the later sample may have been obtained from younger trees than those previously referred to.

The results obtained at the Imperial Institute are the most satisfactory of all those hitherto recorded, so far as the proportion of tannin to non-tannins is concerned, and although it seems doubtful whether the bark would be of sufficient value, regarded solely from the tanning point of view, to make its exportation to Europe remunerative, it is a promising material for the production of a concentrated extract, if a method could be devised for reducing the colour.

4. KAHUA BARK FROM INDIA

Kahua bark, the product of *Terminalia Arjuna*, a large tree common throughout the Peninsula of India, is much used in parts of the Central Provinces for tanning purposes. An interesting account of the methods employed in the Nimar District will be found in an article by D. O. Witt, in *Indian Forester*, Vol. xxxiv, No. 10, October 1908, pp. 583–590.

The bark is smooth and flakes off naturally in thin irregular sheets. It has been found possible to chip it off in small pieces by means of a specially devised cutter, so that it can be harvested without harm to the tree.

A sample of the bark was forwarded to the Imperial Institute in June 1931 by the State Chemist, Bhopal, for examination. It was stated that a considerable amount of experimental work had been carried out with a view to manufacturing an extract from the bark, but that the results had not been altogether satisfactory. It was therefore desired to ascertain whether the bark, of which Central India could furnish 5,000 tons annually, would be worth shipment to Europe.

The sample consisted of very pale pinkish-brown bark, mostly in the form of powder, some small fragments being also present.

The material was examined with the following results, which are shown in comparison with the corresponding figures for a sample of Kahua bark examined in 1918 by Dr. J. Gordon Parker and the range of figures recorded by Fraymouth and Pilgrim (*Indian Tanstuffs and their Tannage*):

—	Present sample.		Figures obtained by J. G. Parker.	Range recorded by Fraymouth and Pilgrim (for moisture-free material).
	Material as received.	Moisture-free material.		
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	8·1	—	10·8	—
Insoluble matter	58·8	64·0	58·7	67·5 to 72·7
Extractive matter (non-tannin)	15·6	17·0	9·2	10·5 to 12·9
Tannin	17·5[1]	19·0[1]	21·3	16·8 to 19·6
Ash	13·9	—	—	—
Tintometer readings[2]				
Red	4·0	—	—	5·9 to 12·3
Yellow	11·9	—	—	8·8 to 21·25
Black	—	—	—	0 to 0·2

[1] *Analysis made by the Official International Method of Tannin Analysis (Hide Powder Batch C.*3).

[2] *Determined for a solution containing* 0·5 *per cent. of tannin in a* 1 *centimetre cell.*

The material yielded a buff-coloured, fairly soft leather, of firm texture.

The above figures show that the present sample of crushed Kahua bark contained an amount of tannin which was about the average of the results previously recorded. It also contained, however, a large proportion of soluble non-tannin matter, which renders it undesirable for the manufacture of extract.

Kahua bark in the form of powder would be unattractive to purchasers in the United Kingdom, where the bark would be preferred either in the form of pieces or in a chopped condition, the possibility of adulteration being thus avoided. In view of the fact that chopped wattle bark containing about 30 per cent. of tannin is now obtainable in London at £8 3*s*. per ton c.i.f., material of the quality of the present sample, i.e. containing only 17 per cent. of tannin, would be worth considerably less, unless it should be found by tanners to possess properties rendering it of higher value for some special purpose.

ESSENTIAL OILS

1. CEDAR-WOOD OIL FROM KENYA

IN the preparation of the East African cedar wood (*Juniperus procera*) for export and local use, a considerable amount of waste is produced. The possibility of utilising this waste wood as a source of cedar-wood oil is receiving attention in Kenya, and two samples of oil distilled in the Scott Agricultural Laboratories at Nairobi were forwarded to the Imperial Institute by the Agricultural Chemist in December 1930 in order to ascertain their quality and commercial value.

The samples were as follows :

A. " *Fairly typical East African cedar-wood oil.*" A pale yellowish-brown oil, containing a quantity of fine needle-shaped crystals, up to ¼ in. in length, and colourless rhombic crystals mostly about ⅛ in. square.

B. " *Unusual East African cedar-wood oil.*" A dark reddish-brown oil, free from crystals.

The crystals present in sample A were first separated, and the approximate amounts, by weight, of both types in the original oil were found to be as follows :

	Per cent.
Needle-shaped crystals	4·2
Rhombic crystals	3·4
Total	7·6

After purification by washing with petroleum ether it was found that the needles melted at 86° C. and the rhombic crystals at 86·5° C. A mixture of needles and rhombs melted at 86° C., indicating that the two types of crystal were identical in nature and consisted of cedrol. Both types had a rather weak camphoraceous odour.

The physical and chemical constants of a representative portion of sample A, after warming to dissolve the cedrol crystals, and those of the "unusual" oil (sample B) as received, are shown in the following table, in comparison with those obtained for a sample of cedar-wood oil from Kenya previously examined at the Imperial Institute from which no solid cedrol had separated ; and with the constants recorded by Gildemeister for (*a*) East African cedar-wood oil, and (*b*) commercial American cedar-wood oil (from the allied species *Juniperus virginiana*).

—	Cedar-wood oil from Kenya.			Cedar-wood oil.	
	Present samples (*J. procera*).		Previous sample (*J. procera*).	Figures recorded by Gildemeister for	
	A.[1]	B.		East African cedar-wood oil (*J. procera*).	American cedar-wood oil (*J. virginiana*).
Specific gravity 15·5°/15·5° C.	0·9597	0·9448	0·9705	0·968 to 0·988	0·943 to 0·964
Optical rotation α_D	− 47·02° at 24° C.	(Too dark to obtain reading)	− 56·20° at 23° C.	− 16° to − 38·5°	− 18° to − 42°
Refractive index n_D20° C.	1·5020	1·4988	1·506	1·480 to 1·509	1·50 to 1·51
Acid value	1·4	0·7	—	1 to 15	up to 1·8
Ester value	1·2	1·4	—	1 to 9	up to 12
Ester value after acetylation	31·3	13·1	—	70	26 to 68
Solubility in 90 per cent. alcohol at 15·5° C.	Soluble in 10·6 vols.	Soluble in 15·5 vols.	Soluble in 0·6 vol.	Soluble in 0·5 to 5 vols.	Soluble in 10 to 20 vols.

[1] *After warming to dissolve the crystalline cedrol which had separated.*

Samples of both oils, A and B, were submitted to two firms of essential oil distillers in London, who furnished the following reports respectively:

(1) "With regard to the quality of the oils, A is superior to B, but both contained considerably less cedrol than English-distilled oil, the latter as a rule having a specific gravity of 0·96 to 0·97. The value of the oil would be between an English-distilled oil and commercial American cedar-wood oil, the present price of which is 1*s.* 6*d.* to 1*s.* 8*d.* per lb. We should think that for limited quantities the value might be about 2*s.* per lb. for A and slightly less for B."

(2) "*Sample A* is an oil with a clean odour, but different from American Oil. It might prove of value in certain perfumes.

"*Sample B* has been spoilt in distillation and has a burnt odour; otherwise it closely resembles the American oil.

"In respect of cedar-wood oils generally from East Africa, we would state that we have had samples from several quarters recently, all of which have shown a considerable variation."

The present investigation has shown that the constants of sample A, the fairly typical East African cedar-wood oil, agree moderately well with those of American cedar-wood oil, although the optical rotation (like that of the previous sample from Kenya examined at the Imperial Institute) is higher than the recorded figures for the American oil. The ester value after acetylation of sample B, the unusual East African cedar-wood oil, falls considerably below the lower limit for American cedar-wood oil. Both samples resemble the American oil as regards solubility in alcohol, the solubility in 90 per cent. alcohol being markedly less than that of the previous sample from Kenya and the recorded figures for East African cedar-wood oil.

The odour of sample A is more satisfactory than that of sample B, but the quality of the latter would probably be improved by redistillation. Judging from the dark colour, odour and the results of the chemical analysis it would appear that some of the cedrol had been decomposed during the distillation of sample B.

2. *BRACHYLAENA HUTCHINSII* OIL FROM KENYA

A sample of oil distilled from the wood of *Brachylaena Hutchinsii* in the Scott Agricultural Laboratories at Nairobi was forwarded to the Imperial Institute by the Agricultural Chemist in December 1930. E. Battiscombe (*A Descriptive Catalogue of some of the Common Trees and Woody Plants of Kenya Colony*, London, 1926), describes the tree, which belongs to the natural order Compositæ, in the following terms : " A tall, deciduous timber-tree of first-class economic importance. Attains a height of 90–100 ft., with a diameter of 30 in. It is distributed from the coast to an altitude of 6,500 ft., and is confined entirely to the country east of the Rift valley. It attains its maximum size at the limit of the altitude where it just overlaps with the Cedar (*Juniperus procera*) zone. Its distribution ceases abruptly at about 6,500 ft. The wood is bright brown in colour, slightly scented, hard, easy to work, very fissile and is extremely durable ; termites do not attack it. Weight 60 lb. per c. ft."

The Agricultural Chemist stated that the oil forwarded for examination was distilled from material obtained from the coastal forests.

The sample received at the Imperial Institute consisted of oil which was very slightly turbid owing to the presence of moisture. The clear oil obtained on filtration through paper was pale yellowish-brown and had a rather weak odour somewhat resembling that of vetiver.

The oil was found to have the following constants :

Specific gravity at 15·5/15·5° C.	0·9743
Optical rotation α_D	− 1·91° at 24° C.
Refractive index n_D20° C.	1·5103
Acid value	1·2
Ester value	10·1
Ester value after acetylation	101·8
Phenols (by absorption)	nil.
Aldehydes and/or ketones (by the bisulphite method) . . . . . . *per cent.*	4
Solubility in 80 per cent. alcohol at 15·5° C.	Insoluble even in 30 vols.
Solubility in 90 per cent. alcohol at 15·5° C.	Soluble in 0·3 vol. No turbidity on further dilution.

The above results indicate that (apart from the small amount of aldehydes and/or ketones present) this oil probably consists mainly of sesquiterpenes and sesquiterpene alcohols. The figure obtained for the ester value after acetylation corresponds to the presence in the oil of 43·3 per cent. of sesquiterpene alcohol, $C_{15}H_{24}O$ (or 43·7 per cent. $C_{15}H_{26}O$).

The amount of oil available was not sufficient for the investigation of its composition.

The oil was submitted to two firms of essential oil distillers in London, who furnished the following reports respectively :

(1) " This oil is new to us, but we do not think it has any wide use except as a possible substitute for Guaiacum wood oil."

(2) " A fine oil, resembling vetiver but more delicate. It should find a ready application in heavy perfumes of the oriental type. We should estimate the value at between 10*s*. and 15*s*. per lb. If there is any of this oil available for sale, we shall be pleased to have an offer."

This oil has a pleasant and persistent odour, which would probably render it suitable for use in soap perfumery and as a fixative. It has been suggested to the Kenya authorities that if it is possible to proceed further in the matter a small trial shipment should be prepared and forwarded to the Imperial Institute for sale to the second firm mentioned above, with an indication of the minimum price likely to be remunerative in large-scale production.

3. *Leptospermum citratum* Oil from Australia

The sample of oil which is the subject of this report was forwarded to the Imperial Institute by the Curator of the Technological Museum, Sydney, in April 1931.

It was stated that plantations of the lemon-scented " tea-tree " (*Leptospermum citratum*), the leaves and terminal twigs of which yield the oil, had been established in New South Wales, and that their extension was considered desirable. The present sample of oil was therefore sent for examination in order to ascertain its uses and value and the possibility of marketing such oil in the United Kingdom.

The sample consisted of a clear, bright yellowish-brown oil, with a strong lemon-like odour.

The oil was found to have the following constants, which are shown in comparison with the ranges of corresponding figures recorded in Australia by Penfold :

	Present sample.	Constants of *L. citratum* oil recorded by Penfold.
Specific gravity at 15·5/15·5° C.	0·8882	0·8792 to 0·8928
Optical rotation α_D	+ 3·12° at 22° C.	+ 2·75° to + 5°
Refractive index n_D20° C.	1·4735	1·4688 to 1·4757
Aldehydes :		
By bisulphite method (by volume) *per cent.*	98·5	90 to 95
By Penfold and Arneman's hydroxylamine method (by weight) *per cent.*	73·5	71 to 85
Solubility in 70 per cent. alcohol (by volume) at 15·5° C.	Soluble in 2·5 vols.	Soluble in 0·9 to 1·3 vols.[1]

[1] *Determined at* 15° *C., using alcohol of* 70 *per cent. strength by weight, equivalent to* 76·9 *per cent. by volume.*

From these results it will be seen that the constants of the present oil fall, for the most part, within the range of figures previously recorded by Penfold (*Perfumery and Essential Oil Record*, 1929, **20**, 395 ; *Bulletin No.* 5, 1923, *Technological Museum, Sydney*). The solubility of the present oil is, however, less than that found previously and the amount of aldehydes is rather higher than the recorded figures.

The oil was submitted to firms of (*a*) soap manufacturers, and (*b*) essential oil distillers, who furnished the following reports respectively :

(*a*) " We have carried out a variety of experiments with the sample of the above oil received from you, and find that its effect in soap can be paralleled with adjusted quantities of Java citronella oil and lemongrass oil, although in this case the odour of the Leptospermum product is somewhat finer. If a better, although more costly match is required, it can be obtained by using adjusted quantities of *Eucalyptus citriodora* oil and citral to which minute quantities of a butyric ester have been added. The cost of the latter mixture would place the value of the oil at about 5*s.* per lb., but if the former composition were satisfactory then the value would be reduced to about one half of this. Any use which could possibly be made of the oil would be entirely determined by the price at which it could be put on the market."

(*b*) "When in Sydney in December last the writer had an interview with Mr. Penfold and discussed with him the value of *Leptospermum citratum* oil. At the present time the prices of essential oils of similar type are very low. We refer to such oils as Java citronella, Ceylon citronella and lemongrass oil, all of which are in the neighbourhood of 1*s*. 6*d*. per lb.

"The writer formed the opinion that the oil would find a market, as it would be useful as a soap perfume. It is a mixed aldehyde, and according to the figures which Mr. Penfold put forward contains approximately 50 per cent. citral and 35 per cent. citronellal, the balance being mainly alcohols of the geraniol and citronellol type.

"The trees are easily cultivated, and as they grow close to the ground the gathering of the leaves is easy. Mr. Penfold is of the opinion that they should obtain 3*s*. 6*d*. per lb. for the oil and in normal times this would not be an out-of-the-way figure, but in view of the very low prices ruling for the oils mentioned, it would be necessary to market the oil at a price more in line with that of such oils.

"We would certainly recommend that a consignment of the oil should be sent over for marketing as it is quite possible that soap manufacturers might find it interesting and be prepared to pay a rather higher figure than we have indicated."

As this oil consists principally of citral and citronellal and possesses a very satisfactory aroma, it would have a definite value commercially as a soap perfume, and for this purpose separation of the citral from the citronellal would not be necessary. The presence of citronellal would, however, render the oil unattractive as a source of citral (which is largely employed in the preparation of ionone) so long as oils such as lemongrass oil, which are practically free from citronellal, are readily obtainable.

There seems little doubt that the value of this oil on the London market would be regulated largely by the prices of Cochin lemongrass oil and Java citronella oil, which are now quoted at 1*s.* 7½*d.* and 2*s.* 2*d.* per lb. respectively, and it would appear unlikely that the Leptospermum oil, if produced in large quantities, would command a price much above that of Java citronella oil. The yield of oil mentioned on pages 9 and 10 of *Bulletin No.* 14 (1929) *of the Technological Museum,* viz. 1·0 to 1·5 per cent., is, however, good in comparison with the recorded yields of oil from lemongrass (0·2–0·4 per cent.) and from Java citronella grass (about 0·6 per cent.).

CHARCOAL FROM KENYA FOR POWER PURPOSES

MUCH interest was caused by the publication, in this BULLETIN (1930, **28**, 138), of the results of the examination at the Imperial Institute of samples of charcoal from British Guiana, and of technical trials which were carried out with the charcoals in order to ascertain their suitability for use as fuel in portable gas-producers.

The extension of the use of charcoal as a motor fuel in such producers appears to be worth serious consideration in localities where petrol and oil are expensive, and it may therefore be of interest to give the results of tests which have recently been made on four samples of charcoal from Kenya, where, it is stated, there is abundant waste wood, but that other fuels are expensive.

The four samples of charcoal examined had been made from the undermentioned woods :

(*a*) Mixed forest woods ;
(*b*) *Eucalyptus globulus ;*
(*c*) *Eucalyptus saligna ;*
(*d*) Black wattle (*Acacia mollissima*).

The charcoals had been produced by burning the wood in heaps covered with earth.

RESULTS OF EXAMINATION

The examination of the charcoal, carried out at the Imperial Institute, gave the following results :

—	Mixed Forest Woods.	*Eucalyptus globulus.*	*Eucalyptus saligna.*	Black Wattle.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture at 105° C. .	6·67	4·45	5·26	5·72
Volatile matter (at 600° C.) . .	5·38	6·92	3·69	9·42
Fixed carbon (including matter volatile above 600° C) .	85·42	87·93	89·79	83·35
Ash . . .	2·53	0·70	1·26	1·51
	100·00	100·00	100·00	100·00
Calorific value (bomb).	7,480 calories	7,410 calories	7,510 calories	7,190 calories
Sulphur (S.) . .	0·18 per cent.	0·14 per cent.	0·20 per cent.	0·18 per cent.
Apparent specific gravity . .	0·61	0·48	0·50	0·57
Weight per cubic foot of loosely packed charcoal . .	17·8 lb.	13·6 lb.	16·3 lb.	15·9 lb.

Technical Trials

In order to ascertain the suitability of the charcoals for use in portable gas-producers, representative samples of each were submitted, for practical trials, to a firm manufacturing plant of this type.

The trials were carried out with a one-ton truck fitted with a portable producer-gas plant, the same truck and load being used in each instance over the same measured test course, the driving being carried out as far as possible under normal conditions. The weather during the test was fine and warm, the temperature being 65° to 70° F.

The results obtained are summarised in the following table:

—	Mixed Forest Woods.	*Eucalyptus globulus.*	*Eucalyptus saligna.*	Black Wattle.
Lorry and load .	Standard model.	Do.	Do.	Do.
	Load 1 ton.	Do.	Do.	Do.
Starting time (from time of lighting fire to engine running on gas) . .	12 mins.	11 mins.	11 mins.	10 mins.
Distance covered .	50·9 miles	Do.	Do.	Do.
Time taken . .	2 hrs. 12 mins.	2 hrs. 18 mins.	2 hrs. 18 mins.	2 hrs. 19 mins.
Average speed. .	23·06 m.p.h.	22·06 m.p.h.	22·06 m.p.h.	21·9 m.p.h.
Charcoal used . .	34 lb.	35 lb.	34 lb.	39 lb.
Water used . .	0·376 gal.	0·385 gal.	0·383 gal.	0·367 gal.
Charcoal used per mile . . .	0·667 lb.	0·687 lb.	0·667 lb.	0·766 lb.
Net ton-miles per lb. charcoal . .	1·49	1·45	1·49	1·30
Dust in cleaner .	5 oz.	7 oz.	9 oz.	10 oz.

REMARKS ON THE TESTS

Mixed Forest Woods

Starting up was easy and running entirely satisfactory. The power on hills was excellent and the engine was very lively and flexible. On examination after the trial the filter was found to be quite clean.

Judged from every point of view this charcoal gave excellent results, and is an entirely satisfactory fuel for use with portable gas-producers.

Eucalyptus globulus

The charcoal gave satisfactory starting up, and good power on hills and on the open road. Flexibility of the engine was satisfactory.

On examination at the conclusion of the test the gas cleaner was in a satisfactory condition and the filter was found to be quite clean.

This fuel is quite satisfactory for use with portable gas-producers.

Eucalyptus saligna

Starting up was satisfactory when using this charcoal, and the road performance very good. Power on hills was very good and the general running and flexibility excellent.

On examination at the conclusion of the test the filter contained a small quantity of fine dust, but was in a satisfactory condition.

The results obtained from this fuel are quite satisfactory.

Black Wattle

When this charcoal was used as the source of gas, starting up was easy, but the charcoal gave somewhat more smoke than usual. Running was quite satisfactory, the power on hills being good and the flexibility normal.

On completion of the test the cleansers were in a satisfactory condition, the filter clean, and, in general, the results obtained from this sample were satisfactory.

The firm who carried out the above practical road trials were of the opinion that while the four samples of charcoal submitted were satisfactory for use with portable producer-gas plants, that made from mixed forest woods was the best fuel for the purpose. It gave easy starting up, very good power both on hills and on the open road, and excellent flexibility. In addition, it was hard, and when broken up gave less smalls and dust than did the other samples. It also gave a greater weight of fuel per cubic foot of hopper space, with the result that the distance covered per hopper charge was greater than in the case of the other samples.

The smalls and dust given by the *Eucalyptus saligna* charcoal when it was broken up were considerable. If the smalls and dust were made into briquettes (carbonite), this charcoal would make an excellent fuel for use with portable gas plants.

The smalls and dust from all the samples, if made into briquettes, would result in considerable economy and yield fuel of a high standard.

The following table, supplied by the same firm, shows the relative running costs of the one-ton truck, using mixed forest wood charcoal and petrol, over 100 miles :

COMPARATIVE TABLE (CHARCOAL AND PETROL)

Charcoal used . . . Mixed Forest Woods.
Petrol used . . . Standard English brand. Distillation = 35 per cent. @ 100° C. Sp. Gr. @ 10° F. = 738.

Costs :					s.	d.
Charcoal	@ £1 per ton.	Quantity required	67 lb.	. . =		7·1
"	@ £2 "	" "	67 "	. . =	1	2·2
"	@ £3 "	" "	67 "	. . =	1	9·3
Petrol	@ 1*s.* per gall.	" "	7·3 gall.	. . =	7	3·6
"	@ 1*s.* 6*d.* "	" "	7·3 "	. . =	10	1·4
"	@ 2*s.* "	" "	7·3 "	. . =	14	7·2

It will be seen from this table that the use of charcoal as motor fuel would appear to offer a considerable economy.

ARTICLE

FIBRES OF ASCLEPIAS SPP.

THE various species of Asclepias have long been recognised as potential sources of fibrous products. In general, the plants yield fibre of two different kinds, viz. (1) the floss or silk-cotton, resembling thistle-down in appearance, which adheres to the seed as a mass of fine, lustrous, silky filaments, and (2) the stem fibre, derived from the bast tissue of the bark. Many brief references have been made to these Asclepias fibres in the technical literature and in agricultural and botanical reports, but apparently no comprehensive statement regarding them has hitherto been published.

(1) The floss or silk-cotton borne by these plants resembles the commercial product known as " kapok " (see this BULLETIN, 1926, **24**, 18–36) which is exported in considerable quantities from Java and is employed for stuffing cushions, pillows, mattresses and similar articles, and also for the manufacture of buoys, life-belts and life-saving jackets. The Asclepias flosses, however, are of less value for these purposes than kapok owing to their inferior resiliency, and this inferiority may be associated with the fact that the fibres are usually quite straight whilst those of kapok have a somewhat crinkled or curly appearance.

(2) The bast fibre of the stems of most species of Asclepias is characterised by the comparatively ready manner in which the ultimate fibres can be separated, and for this reason it is generally difficult to obtain long strands of even length. It will be observed that this has been found to be the case with most of the species which are dealt with in the following pages. This property, however, enables the product to be readily reduced to its ultimate fibres (a process which has been termed " cottonisation ") and attention has been given to the possibility of spinning such material, especially in admixture with cotton.

The species of Asclepias, of which in all some 150–160 have been described, occur mostly in Africa and the warmer parts of North and South America. The genus is particularly well represented in the United States. The plants are all perennial herbs and are commonly known as milk-weeds, from the fact that they contain a milky juice or latex, whilst in North America they are sometimes called silk-weeds owing to the silky seed-hairs.

In the following pages the species which have been considered from the point of view of fibre production are arranged in alphabetical order.

ASCLEPIAS CURASSAVICA

This plant, known as "wild ipecacuanha," occurs in the Southern United States, Mexico, the West Indies and parts of South America. It is common in Yucatan and is said to have been introduced from South America into India and other parts of the East.

Floss.—It has been stated by Dodge (*Useful Fibre Plants of the World*, p. 71) that it has been claimed that the seed-hairs of *A. curassavica* are stronger than those of any other species of Asclepias that have been considered.

According to Jules Grisard (*Bulletin de l'Office Coloniale*, 1912, p. 37) the ripe fruits contain a mass of soft, fine, silky fibre which is employed for stuffing pillows and cushions, but cannot be utilised alone for textile purposes as the fibres lack length, elasticity and tenacity. It has been found possible, however, to make textiles from them in conjunction with cotton.

ASCLEPIAS FRUTICOSA (*Gomphocarpus fruticosus*)

Asclepias fruticosa is commonly and widely distributed throughout South Africa, being specially abundant in the neighbourhood of Pretoria and Johannesburg, where it is known as "melkbosch."

Floss.—A sample of the floss of this plant was received at the Imperial Institute from the Transvaal in 1911. It consisted of lustrous, very pale yellow fibre, resembling thistledown in appearance, and contained a considerable proportion of seeds, capsules and pieces of twig.

The yield of fibre obtained on passing the sample through a roller cotton-gin was only about 28 per cent., and the ginned product still contained a small quantity of fragments of capsules.

The fibre was weak and brittle, as is usually the case with flosses. Its strength was about equal to that of Java kapok, but it was much inferior to the latter in resiliency. The length of the fibres varied from 0·7 to 1 in. It was considered that the floss could probably be utilised as a stuffing material in upholstery but would be less valuable than kapok.

From the reports of brokers to whom samples were submitted it appeared that the ginned product would probably realise 2½*d.* to 4½*d.* per lb., when Java kapok was quoted at 8½*d.* to 9½*d.* per lb. and Calcutta kapok at 5*d.* to 5¾*d.* per lb. (December 1911). For upholstery purposes the floss would have to be freed from the seed, but this could probably be effected by treating it in one of the machines specially designed for cleaning kapok.

A further sample of the floss was received from the Transvaal in 1916. It consisted of clean, very soft, lustrous floss, varying from pale yellow to cream in colour and, like the earlier sample, was inferior to kapok in resiliency. The fibres were from 0·6 to 0·9 in. in length and had a diameter of 0·0005 to 0·0011 in. The strength was fairly good with regard to longitudinal stress, but the fibres were somewhat brittle, as is usually the case with such products. Microscopical examination showed that the fibres were quite smooth and had very thin walls and a wide lumen.

Samples of the floss were submitted to a firm of brokers and to manufacturers of upholstery materials, who reported as follows:

(*a*) The brokers regarded the material as similar to the floss known in commerce as "Akund," which is derived from species of *Calotropis*. They stated that there is only a limited consumption of the product in the United Kingdom, where kapok is preferred, and that before the war most of the "Akund" went to Germany. The firm considered the nominal value of the material to be about 5½*d.* or possibly 6*d.* per lb. in London (July 1916).

(*b*) The manufacturers stated that the floss was of low quality and that there would be less demand for it than for kapok. They valued the material, if marketed free from seed like the sample submitted to them, at from £25 to £30 per ton (i.e. about 2¾*d.* to 3¼*d.* per lb.) c.i.f. London (July 1916).

In view of the large demand for kapok for use in stuffing life-belts and other life-saving devices, a sample of this floss was submitted to a manufacturer of such appliances. He stated that the material generally resembled akund, kapok and bombax floss, but on preliminary examination appeared to be much inferior to them in buoyancy.

The following reference to the floss of *Asclepias fruticosa* was made by C. R. Dodge in his *Descriptive Catalogue of the Useful Fibre Plants of the World* issued by the United States Department of Agriculture in 1897.

" The down of this species is used in Italy to a small extent as wadding. The plants only thrive in favourable situations. The plant is known as *Albero della seta*, or silk tree."

Bark Fibre.—Samples of strips of bark, labelled " Melk Bosch, *Asclepias fruticosa*," and a small specimen of the extracted fibre, were forwarded from the Transvaal in 1905.

The strips of bark were of a pale yellowish-green colour, and from 18 to 22 in. long. A sample of fibre was extracted from the bark by boiling it with water or very dilute alkali and scraping and washing the product. The material thus obtained consisted of bundles or groups of fibres which had been partially resolved into their ultimate fibres, and was clean, lustrous, fairly soft to the touch, and of a pale greyish colour. The product was of poor strength, and the ultimate fibres were 0·7 to 1·2 in. long, with an average length of 0·9 in.

On microscopical examination, the fibres were found to be smooth, of even diameter, and to bear transverse markings, and in these respects resembled flax fibre. The diameter varied from 0·0004 to 0·0010 in., with an average of 0·0006 in.

A portion of this fibre, prepared at the Imperial Institute, was submitted to chemical examination with the following results :

	Per cent.
Moisture	6·6
Nitration (gain) . . .	46·2 (calculated on the dried fibre)
Cellulose	84·2 ,, ,, ,,

The fibre, after treatment with chlorine, gave little or no coloration with solution of sodium sulphite, and the nitrated product was nearly white. These facts indicate that the fibre is not lignified, but belongs to the pectocellulose class of fibres, of which flax is the most important member. On comparing these results with those yielded by samples of the fibre of *Asclepias semilunata* from Uganda (p. 452), it is evident that the fibres are very similar in composition :

	Asclepias fruticosa	*Asclepias semilunata*	
		(1)	(2)
	Per cent.	*Per cent.*	*Per cent.*
Moisture	6·6	7·7	9·9
Nitration (gain) . . .	46·2	46·9	49·7
Cellulose	84·2	80·4	88·1

Both fibres contain a very large proportion of cellulose, and undergo a considerable increase of weight on nitration.

The small specimen of extracted fibre, which accompanied the strips of bark, was white, lustrous and flax-like. The material resembled the fibre of *Asclepias semilunata* of Uganda but was somewhat finer. The fibre was less broken up than the sample prepared at the Imperial Institute and was very clean, of fair but uneven strength and harsh to the touch. The ultimate fibres were very fine and lustrous.

In reporting on these samples the Imperial Institute stated that the fibre of *Asclepias fruticosa* possesses valuable properties, and, if the material could be easily extracted from the bark without sacrificing its length, it could no doubt be spun into a yarn resembling that of flax or of ramie.

Two further samples of this fibre were received at the Imperial Institute in 1915.

Both had been prepared at the Botanical Laboratories, Pretoria, No. 1 being obtained from plants collected in August and No. 2 from plants collected in October when in flower.

No. 1.—This consisted of rather harsh fibre of poor lustre, nearly white with a greenish tinge. The fibre was clean but not well prepared; it was of fair strength, and varied in length from 14 to 30 in., being mostly from 21 to 22 in.

No. 2.—This sample closely resembled No. 1 in general appearance. The length varied from 16 to 26 in., being mostly about 20 in.

The samples were submitted to chemical examination with the following results:

		No. 1.	No. 2.
		Per cent.	*Per cent.*
Moisture		8·0	8·4
Expressed on the moisture-free material	Ash	1·5	1·4
	α-Hydrolysis, loss	13·1	13·0
	β-Hydrolysis, loss	16·2	15·4
	Acid purification, loss	7·0	7·0
	Cellulose	82·0	81·5
	Gain on nitration	51·5	53·5

The richness of this Asclepias fibre in cellulose and the large increase of weight on nitration confirmed the results of the previous investigations.

The samples were submitted for valuation to a firm of merchants in London, who valued No. 1 at £37 to £38 and No. 2 at £32 to £33 per ton (March 1915). They based this valuation on a comparison with Sisal hemp which, if not less than 3½ to 4 ft. in length, at that date realised about £50 per ton. The firm added that it was not advisable to cut any fibre plants under 3 to 3½ ft. in length, as spinners of hard fibres object to using any material measuring under 3 ft.

ASCLEPIAS GLAUCOPHYLLA

Specimens of the floss and bast fibre of this plant were forwarded to the Imperial Institute by the Chief Agriculturist at Salisbury, Southern Rhodesia, in 1929. It was stated that they had been submitted to the Department of Agriculture by a Rhodesian farmer, and it was desired to learn whether they would be of commercial value. Botanical specimens consisting of the stems, leaves and fruit were also received. These were submitted by the Imperial Institute to the Director of the Royal Botanic Gardens, Kew, who reported that the plant is *Asclepias glaucophylla* Schlechter.

Floss.—This consisted of cream-coloured, straight, very lustrous fibres, about ¾ to 1 in. in length. The only commercial use for material represented by this sample would be as a substitute for kapok for upholstery purposes. It is, however, inferior to kapok in resiliency and would not realise more than 4*d.* to 5*d.* per lb., in London, with Java kapok at 1*s.* 0¼*d.* to 1*s.* 0¾*d.* per lb. (July 1929).

Bark Fibre.—Two samples of the fibre from the stem of the plant were received.

Sample No. 1 consisted of unevenly prepared fibre, in strands and ribbons ranging from 2 in. to 2 ft. in length; some of the fibre had not been freed from the outer barky tissue. The separated fibre was largely in short pieces, which were in a rather matted and fluffy condition owing to the fibre having been partially resolved into ultimate fibres, which projected from the surface of the fibre strands. The strands which were clean and fairly free from this defect were pale in colour, fine and of good lustre. The strength of the strands varied according to the degree of preparation; that of the clean compact strands was good.

Sample No. 2 consisted of fibre of similar character to No. 1, mostly about 2 ft. in length. It was better prepared than most of the fibre in No. 1.

The bark fibre of *Asclepias glaucophylla* is rather similar in character to fibre from other species of Asclepias (viz. *A. semilunata* and *A. fruticosa*) examined at the Imperial Institute (see pp. 451 and 444).

In the condition of these samples, *A. glaucophylla* bark fibre would be of little value, but if it were possible to obtain the fibre in fine, smooth, compact filaments, about 3 ft. long and of good strength, there is little doubt that a market could be found for commercial consignments at good prices in the United Kingdom.

ASCLEPIAS INCARNATA

Asclepias incarnata is a perennial plant which grows on wet lands over an extensive area in North America. It attains a height of 5 to 6 ft. In 1890 attention was directed to the possibility of growing the plant in Minnesota but, although it was concluded that it might be profitably cultivated for fibre, it was considered that there would be no special advantage to be derived from the crop as it is not superior to ordinary hemp which was found growing wild in many localities in which *A. incarnata* was abundant. On the other hand, it was claimed that the Asclepias would produce as much fibre per unit area as hemp and with less labour, and that it would thrive on waste land where no other crop would grow. At a later date cultural experiments were carried out under the auspices of the United States Department of Agriculture which seemed to indicate that the plant does not thrive on the uplands and does not succeed so well under cultivation as in the wild state.

Reference to this fibre was made by Neish in his article on "Milkweed" (*Journal of the Society of Chemical Industry*, 1913, **32**, p. 72). He states that the fibre can be obtained of a length from 3 to 6 ft. if the process of preparation is carefully regulated. Plants cut green and subsequently dried were retted in a similar manner to the ordinary retting of flax, and in nine days decomposition had proceeded sufficiently to enable the fibres to be removed mechanically. Some plants which had gone to seed gave all the fibre quite readily by a simple mechanical process followed by a simple carding operation. The fibres resembled flax very closely. They were, however, stronger than flax but not quite so strong as fibres of a similar diameter of Manila hemp. The silky appearance, whiteness and strength of the fibre render it worthy of consideration as a possible textile fibre.

Six samples of fibre products derived from *Asclepias incarnata* plants grown in England were submitted to the Imperial Institute in 1931 and were made the subject of the investigation described in the following report.

The six samples were as follows:

No. 1.—This sample consisted of portions of pale brown stems, 16 in. in length and from $\frac{3}{16}$ to $\frac{5}{16}$ in. in diameter. The stems possessed a very fibrous bark, surrounding a hard, brittle, woody portion, and were hollow. Small nodes were present, spaced at fairly regular intervals of from 3 to 4 in.

No. 2.—This consisted of a bundle of rather harsh, fairly lustrous fibre, generally pale brown in colour. The fibre, which had apparently been extracted from stems similar to the above, was fairly well separated, but some incompletely divided, barky ribbons were present. The material possessed good strength and varied in length from 1½ to 2½ ft., being mostly about 2 ft.

No. 3.—This sample was a hank about 2 ft. long consisting of soft, silky, very lustrous strands of fibre. The strands were rather matted and could be readily broken down into the ultimate fibres.

No. 4.—This was composed of material similar to No. 3 but of inferior preparation, the strands being shorter (only 5 to 12 in. in length) and more matted and tangled. They were white and equally lustrous to No. 3 and could be readily pulled apart into ultimate fibres. A very small quantity of fragments of the woody portion of the stem was present.

No. 5.—This consisted of a mass of small tangled and matted lumps of lustrous, white, ultimate fibres, up to 2 in. in length, intermixed with a quantity of woody matter. The sample appeared to consist of "wasty" fibre of inferior length which had been separated in the preparation of Samples 3 and 4.

No. 6.—This sample consisted of material of similar preparation to Sample 3, but dyed crimson.

Physical Properties.—The ultimate fibres separated from Sample 3 were found on microscopical examination to have the following dimensions:

	Length in inches.	Diameter in inches.
Maximum . .	2·3	0·0014
Minimum . .	0·7	0·0005
Average . .	1·2	0·0008

Samples Nos. 3 to 5 and the dyed sample No. 6 represented products obtained by the degumming and disintegration of the fibre, thus effecting its resolution into the ultimate fibres, which were highly lustrous and of fair strength. These ultimate fibres have about the same average length and diameter as cotton, although their dimensions extend over a wider range.

As compared with cotton, the greater unevenness in the length of these fibres and the absence of the natural twist might cause trouble in spinning them with machinery built for cotton, but there seems a possibility that fairly soft fabrics of useful quality could be economically prepared from such ultimate fibres if the ordinary cotton machinery could be successfully adapted to spin them without much wastage.

Results of the chemical examination of the prepared fibre (Sample No. 3) are given below in comparison with corresponding figures obtained for cotton fibre :

(*a*) The sample was found to contain 6·2 per cent. of moisture and to yield 0·9 per cent. of ash. Clean raw cotton contains from about 6·5 to 8·0 per cent. of moisture and gives from 0·12 to about 1·7 per cent. of ash.

(*b*) The following results were obtained in experiments carried out to ascertain the nature and quality of the cellulose present, in comparison with the corresponding figures obtained at the Imperial Institute for clean raw cotton of American and Egyptian types. The figures are expressed in each case on the moisture-free fibre.

	Present sample.	Figures obtained with Cotton.	
		American type.	Egyptian type.
α-Cellulose . *per cent.*	89·7	95·0	95·2
Copper number . .	1·0	0·5	0·4

These results show that the present material contains a fairly high percentage of the stable α-cellulose, although the amount present is rather lower than that found in the samples of cotton used for comparison and is about equal to that occurring in the high-grade bleached chemical wood pulps used for the manufacture of artificial silk.

(*c*) On mercerisation, a process in which the fibre is left for one hour at the ordinary temperature in contact with concentrated sodium hydroxide solution (of a strength equivalent to 33 per cent. Na_2O), the present fibre showed a loss of 15·2 per cent. as compared with a loss of 5·4 per cent. sustained by a sample of clean raw cotton. This shows that the present material is more easily attacked than cotton cellulose by strong caustic alkali at the ordinary temperature.

(*d*) In determinations of the gain on nitration effected by submitting the fibre to the action of a mixture of equal volumes of concentrated nitric acid (sp.gr. 1·42) and sulphuric acid (sp.gr. 1·84) for one hour at the ordinary temperature, the present fibre showed a somewhat higher initial gain than cotton ; the nitrated material was, however, considerably less stable than the nitrated cotton.

The results of this investigation show that the *Asclepias incarnata* fibre, as represented by sample No. 3, contains rather less total cellulose than cotton and a smaller amount of the more durable and valuable α-cellulose. Moreover, the cellulose is rather less stable than cotton cellulose.

In general, the Asclepias fibre appears to possess satisfactory qualities, but would probably prove somewhat less durable than cotton.

ASCLEPIAS PHYSOCARPUS

In the Annual Report of the Department of Agriculture at Bombay for 1914–15 the following note is made of a trial which was carried out at the Agricultural College Farm, Poona District, Deccan, with the " Natal fibre " plant (*Asclepias physocarpus*). " This was tried on a one-twentieth-acre plot. It gave 13½ lb. of fibre which was pure white in colour. But the fibre could not be peeled off in long threads and broke off in small bits."

ASCLEPIAS SEMILUNATA

Floss.—A sample of the seed-hairs of this plant was forwarded to the Imperial Institute from Uganda in 1908. It consisted of soft, lustrous, fairly resilient fibre, and was generally of an even pale yellow colour, but some dark brown stained portions were also present. The strength was rather poor, as is usually the case with flosses, and the length of the fibres varied from 1·0 to 1·6 in.

This floss was rather superior to that of *A. fruticosa* (see p. 442).

Bark Fibre.—A sample of fibre derived from a plant occurring in Bugangadzi was received at the Imperial Institute in 1905. Specimens of the plant, which were forwarded to Kew, were identified as *Asclepias semilunata*, N.E. Br.

The fibre was lustrous and almost white, but was marked by a few patches of a black substance, which had not been removed in the cleaning process. It possessed considerable strength, and its length ranged from 2 to 3 ft., some shorter fibre also being present.

The fibre was submitted to examination and the following report was furnished to the authorities in Uganda.

The chemical examination furnished the following results:

		Per cent.
Moisture		7·7
Expressed on the moisture-free material	Ash	3·2
	α-Hydrolysis, loss	12·9
	β-Hydrolysis, loss	19·2
	Mercerisation, loss	6·0
	Acid purification, loss	6·2
	Gain on nitration	46·9
	Cellulose	80·4
Length of ultimate fibres		20–27 mm. (0·8–1·08 in.)

The percentage of cellulose is high, and the fibre is evidently of good quality, though the losses on hydrolysis and acid purification are considerable. The marked action of weak alkalis upon the fibre, as shown by the losses occurring on hydrolysis, suggests that it may not prove very durable in use, whilst the high loss on acid purification indicates that more careful and thorough cleaning is desirable.

The nitrated fibre was nearly white, and no purple colour was produced when the fibre was treated with sodium sulphite after chlorination, both of which facts indicate that the fibre is not lignified, but consists probably of pectocelluloses. In this respect, and also in the high percentage of cellulose, this Asclepias fibre from Uganda resembles the fibres of *Marsdenia* and *Cryptostegia*, and it is noteworthy that these three genera belong to the same natural order, i.e. *Asclepiadacœ* (cf. this BULLETIN, 1903, 1, pp. 121 and 172).

The following statement summarises the results obtained in the examination at the Imperial Institute of the fibres from *Marsdenia tenacissima* and *Cryptostegia grandiflora* for comparison with those furnished by the present sample of Asclepias fibre.

		Fibre of *Asclepias semilunata* from Uganda. *Per cent.*	Fibre of *Marsdenia tenacissima* from India. *Per cent.*	Fibre of *Cryptostegia grandiflora* from India. *Per cent.*
Moisture		7·7	7·7	7·9
Expressed on the moisture-free material	Ash	3·2	1·5	0·95
	Loss on α-hydrolysis	12·9	7·8	5·2
	„ β-hydrolysis	19·2	8·9	9·8
	„ mercerisation	6·0	4·9	4·3
	„ acid purification	6·2	3·5	1·2
	Gain on nitration	46·9	53·9	49·0
	Cellulose	80·4	91·5	92·0
Length of ultimate fibres		20–27 mm. (0·8–1·1 in.)	10–30 mm. (0·4–1·2 in.)	10–50 mm. (0·4–2·4 in.)
„ staple		2–3 ft.	12–13 in.	16–20 in.

A comparison of these figures shows that this sample of Asclepias fibre from Uganda is distinctly inferior to the others, the percentage of cellulose being lower, whilst the ash and the losses on hydrolysis and acid purification are considerably greater. It is possible, however, that the fibre could be improved in these respects by careful preparation. In the case of *Asclepias semilunata*, the length of the ultimate fibres is not so great as in the other two fibres, but it appears to be more uniform, and the staple is much longer.

If the fibre could be obtained more uniform in length and equal to the longest fibres in the present sample, i.e. 3 ft., it was thought by technical experts that it would be suitable for rough textile purposes, and its value (in 1905) would be from £30 to £40 per ton.

It was therefore reported that the fibre of *Asclepias semilunata* appeared worthy of further attention in Uganda, especially if the plant were abundant or could be easily cultivated. In this case efforts should be directed to the production of a uniformly long fibre, as the value of the product in this form would be much greater than if a considerable proportion of short fibres is present.

In 1908 a further sample was received from the Botanical and Scientific Department, Entebbe, Uganda, and was examined with the following results.

The fibre varied in colour from white to pale brown, and was of good lustre and excellent strength. On the whole it was well cleaned and prepared, but some portions were rather gummy and dirty. The greater part of the sample was 3 to 4 ft. long, but some was 5 ft., whilst a small quantity was less than 3 ft. in length.

On chemical examination it gave constants which are recorded below in comparison with those of the earlier sample.

		Present sample. *Per cent.*	Previous sample. *Per cent.*
Moisture		9·9	7·7
Expressed on the moisture-free material	Ash	2·1	3·2
	α-Hydrolysis, loss	10·0	12·9
	β-Hydrolysis, loss	16·5	19·2
	Acid purification, loss	5·3	6·2
	Cellulose	88·1	80·4
	Nitration (gain)	49·7	46·9

These results show that the fibre was of excellent quality and superior to the sample previously examined. The percentage of cellulose is very high. The somewhat large loss on acid purification indicates the presence of gummy matter, which could no doubt be removed in the course of preparation. The value of the material would also be increased if it could be prepared free from the short fibre which is mixed with it. It could be used in the manufacture of rope and twine. The fibre was regarded at that time by commercial experts as worth from £28 to £33 per ton and readily saleable in large quantities, say, 50 to 100 tons at a time.

In 1909, information was supplied by Mr. M. T. Dawe, who was then Officer-in-Charge of the Botanical, Forestry and Scientific Department at Entebbe, which showed that there are several difficulties in connection with the cultivation and preparation of this fibre which render its successful production doubtful. In the first place, the plant seems to be peculiarly liable to the attacks of an insect pest which rapidly destroys the crop. The Government Entomologist was, however, of opinion that this pest might be successfully dealt with. Secondly, the low yield of fibre would probably render its production unremunerative, at any rate if the fibre were extracted by hand. The estimated yield of fibre is 250 to 350 lb. per acre, that is to say, 7 to 10 acres would be required for the production of one ton. Assuming that the clean fibre were worth £30 per ton the value of the produce of an acre would be only £3 to £4 10*s*. After deducting the cost of baling and transport of the fibre it seemed doubtful whether the balance would be a sufficient return for the labour involved in the cultivation of the plant and the preparation of the fibre.

Attempts had been made to extract the fibre with certain hand machines but without success. Moreover, it was considered that none of the existing machines would be capable of extracting the fibre satisfactorily. It was therefore suggested that, before taking further action in connection with the product, efforts should be made to determine whether its cultivation and its preparation in a marketable condition, either by hand or machine, could be profitably undertaken in Uganda.

Reference to *A. semilunata* was made by Mr. Charles A. White in *Tropical Life* (1909, vol. 5, p. 58), who first met with it in Coolgardie, Western Australia, and subsequently in various parts of Africa, including South Africa, the Congo, Uganda and Abyssinia. He stated that " while at Uganda, planting rubber at the head of the Nile at Victoria Nyanza, I wanted some rope for a line, and requested a native to get some, thinking he would get the bast of a banana. Much to my surprise the boy started pulling this particular plant, and drawing the fibre, then twisting it into rope of remarkable strength. I then forwarded samples of rope, fibre and botanical specimens to the Imperial Institute, London, with the result that the plant was identified as *Asclepias semilunata,* and the fibre, if properly prepared, was valued on the London market at £35 per ton."

Mr. White also sent a sample of the fibre to the Minister for Agriculture in New South Wales, who submitted it to rope manufacturers in Sydney. They reported as follows : " The fibre is equal to Manila and is valued at £35 per ton ; the length and colour are good. They would give £35 per ton for it, but the fibre must not be less than 4 ft. long. The quantity submitted was too small to make a test."

With regard to the cultivation of the plant, Mr. White wrote as follows : " The cultivation of *A. semilunata* is simple : sow as you would wheat or oats, after the land has been harrowed ; seed thickly, so as to produce stems 5 to 6 ft. long. It will grow on stony land, on the flat or hill-sides; it requires no irrigation, and will withstand drought with impunity."

With reference to the occurrence of the plant at Coolgardie, Mr. White suggested that seed had been introduced into Australia by the late Baron von Mueller.

ASCLEPIAS SYRIACA

Floss.—According to A. C. Neish and J. W. Burns (*Canadian Chemistry and Metallurgy*, November 1921, pp. 316–319) the seed floss of *A. syriaca* varies in colour from pure lustrous white to a pale yellowish white. It is very soft and fairly resilient and would probably make a satisfactory filling for pillows. Experiments which were carried out in comparison with wool, cotton, kieselguhr and magnesia showed that the floss is an extremely poor conductor of heat and is therefore very suitable for use in quilts, sleeping-bags, etc. With regard to its possible use in life-saving appliances it was found that although it is not capable of supporting quite so great a weight as kapok it retains its buoyancy for a longer time. The fibre is too short and brittle to be woven.

The fibre is composed of lignocellulose, and on ignition yields from 0·9 to 1·48 per cent. of ash, of which 0·2 per cent. is phosphate. The fibre is from 30 to 40 mm. long and consists of a single cell, of cylindrical shape, thicker at the base than at the tip, with thin cell-walls occupying one-tenth of the width of the fibre. It is oval or circular in cross-section and the walls are usually somewhat pitted.

According to Gerhardt (*Industrial and Engineering Chemistry*, 1930, **22**, p. 160), 280 lb. of the floss was obtained from the experimental cultivation of the plant on one-twentieth of an acre, a yield of about 0·5 gram of the floss being given per pod. He also observed that the fibres are straight, and vary in length from 12 to 30 mm. and in diameter from 0·02 to 0·05 mm.; they possess thin cell-walls and a conspicuous lumen. Buoyancy tests carried out by Gerhardt indicated that the *A. syriaca* floss closely resembles kapok in this respect.

Bast Fibre.—Neish and Burns (*loc. cit.*) carried out some experiments to determine the nature of the bast fibre of *Asclepias syriaca.* Some of the stalks were retted for 9 to 10 days at an average temperature of 65° F. They were then washed in clean water, allowed to dry partially and were afterwards passed between grooved rollers which separated most of the fibre from the wood. It was found, however, that the fibre so obtained was practically worthless as a textile material. Efforts were made to prepare the fibre by chemical methods and also by mechanical methods, but without success in either case.

Gerhardt (*loc. cit.*), however, found that by tank retting for 8 days the fibre could be completely isolated. He found that the ultimate fibres vary from 15 to 25 mm. in length and from 0·25 to 0·50 mm. in diameter, and on ignition yield 0·3 per cent. of ash as compared with 1·0 per cent. for the floss. The fibres are soft, pliable, almost white, and closely resemble flax in appearance. They constitute approximately 10 per cent. of the dry weight of the stalks. This figure confirms that obtained by Neish (*Journal of the Society of Chemical Industry*, 1913, **32**, p. 72), who found that one stalk when thoroughly air-dry gave a yield of 9·18 per cent. of fibre.

In a paper by P. Kondratsky (*Faserforschung*, 1928, **6**, p. 141 ; from *Bote f.d. Flachsmarkt* (Moscow), 1927, pp. 301–303) it is stated that the *Asclepias syriaca* of North America grows wild in Russia, and the following observations are made regarding its bast fibre. Fibre could be easily obtained from the stalks without retting and could be freed from adherent tissue by boiling it gently in soap solution, which gives it a silky appearance. The fibre is suitable either for spinning or for cottonisation. A crop of 4,200 kilos. of stems of an average weight of 12 grams each can be harvested from one dessiatine (2·7 acres). The stems yield about 17 per cent. of air-dry fibre, and about 700 kilos. per dessiatine would therefore be obtainable as a maximum or normally 300 to 500 kilos. The fibre resembles flax but is whiter and more lustrous. The ultimate fibres have an average length of 40 to 50 mm. (up to 100 mm.) and a diameter of 0·014 to 0·015 mm. They taper towards the ends and their surface presents a striated appearance.

ASCLEPIAS TUBEROSA

It has been reported by Neish and Burns (*Canadian Chemistry and Metallurgy*, 1921, p. 318) that the bast fibre of *A. tuberosa* is superior to that of *A. syriaca* and other varieties (with the exception of *A. incarnata*), being longer, less brittle and more readily detached from the stem.

NOTES

The Curing of Vanilla.—The following particulars have been compiled from published information in response to enquiries received at the Imperial Institute.

The drying and curing of the pods of vanilla are of much practical importance, since they have a great effect on the value of the final product.

If left to ripen on the plant, the pod, which is at first green, gradually turns yellow (beginning at the lower end) and splits open. It continues to darken, changing through brown to black, and takes about a month to ripen fully. The characteristic vanilla odour, which is not present in the freshly ripened pod, develops as the pods darken. If left to themselves the pods dry up and become brittle and odourless.

The object of the artificial methods of curing that are employed is to accelerate the ripening and to render it uniform throughout the length of the pod, and also, by arresting the natural vegetative processes, to prevent the splitting of the pod which entails loss of perfume.

Methods used in Mexico. (1) *Sun curing.*—Sun curing is the ordinary method of curing adopted in Mexico. The pods are picked when they are just beginning to turn yellow at the end ; if allowed to remain on the plant beyond this stage there is a risk that they may split. The pods are then spread out in single layers on shelves ("camillas") in a clean place, which is well ventilated and protected from rain, and are left for twenty-four hours, during which they lose moisture and shrivel. During this stage they are kept under observation and sorted according to their degree of ripeness, those pods that show a tendency to blacken being smeared thinly with castor oil.

The next day the pods are spread out on tables in the sun, preferably alongside a whitened wall facing south. The tables are covered with sacking, on which are placed woollen blankets, of a dark colour (to conserve the heat), and on these the pods are spread out, singly, with their thick ends towards the sun.

Before sunset, the pods, which are now almost too hot to handle, are placed in boxes. These boxes have themselves stood all day in the sun, and are lined with blanket material that has also been similarly exposed. The pods are piled in the boxes with their thick ends in the centre of the box, and the blanket lining is folded over the top of the pile. In this condition, with every precaution to conserve the heat, the pods undergo the process known as "sweating." After 16–22 hours they have usually acquired a dark brown colour and are removed from the boxes, any pods that have remained green being set aside and treated in ovens (see below).

The pods are then allowed to dry for a period which may last from 20 to 30 days, according to the weather. During this period they are placed on the camillas, advantage being taken of fine days to expose them to the sun for one or two hours at the hottest part of the day. They are also subjected again during this period to the sweating process some 4 or 5 times ; this number should not be exceeded or the pods may become soft and discoloured.

(2) *Oven Curing.*—The curing of vanilla by sun heat is only possible in fine weather. If the weather is unfavourable, recourse is had to the oven method of treatment, which, indeed, is stated to be used increasingly in place of the sun process. The oven process requires close attention and skill in order to avoid loss of material through faulty curing.

The pods are tied up in bundles, of flat rather than cylindrical shape, each consisting of from 100 to 400 pods. Each bundle is wrapped in a woollen covering, then enclosed in sacking, and tied up with cord. The bundles are then placed in an oven.

The oven has been previously heated, and the fire removed, the temperature at which the treatment commences being from 89° C. to 125° C. according to the number of bundles to be treated (the larger the number the higher the temperature). An average number of bundles to be treated at a time is from 16 to 20, for which the commencing temperature would be 111° C. to 115° C. The oven should be made to cool as slowly as possible ; it is recommended that, if it is not in frequent use, the oven should be kept at a high temperature for some time before use, and, in any case, it should first be heated to a higher temperature than that at which it is to be used, and then allowed to cool to the required temperature, a thermometer being placed in the middle of the oven to indicate when this temperature is attained.

The oven being at the correct temperature the bundles are rapidly introduced by means of a rod having a hook at its end, and the oven is then closed.

After 16–22 hours the pods have generally acquired the proper colour, though it is a common practice after about 12 or 14 hours to remove and examine one bundle in order to gauge the further length of treatment necessary. Should the temperature have become too low, the oven is re-heated, the bundles being temporarily removed. Or, less satisfactorily, the bundles may remain in the oven, being protected by damp sacking.

When the bundles are finally removed from the oven they are wrapped in blankets in order that they may cool very slowly. The next day they are exposed in the sun or on the camillas, according to the weather.

For a subsequent 20 to 30 days the pods are dried in the same way as described under "sun curing," and are "sweated" 4 or 5 times.

During the drying process the pods are carefully inspected, and any that are misshapen or unripe, or that have split open, or show mould or abnormal crystallisation, are separated and placed in different classes according to their particular defects.

Finally the pods are graded according to colour, firmness and length. They are made up into packets of 50, and packed in tin boxes, each box containing 60 packets all of the same grade.

Methods Used in Other Countries.—In the French islands of Madagascar and Réunion a process that is commonly employed is treatment with hot water. This is known as the "boiling water" process, as when it was originally introduced the water was employed at a temperature near its boiling point. At present a temperature of 60° C.–65° C. is regarded as more satisfactory.

The pods are placed in baskets according to grades, and the baskets are dipped into a cauldron of hot water for 2 to 3 minutes according to the grade, the larger pods having the longer treatment.

An alternative to this treatment is exposure to steam, the pods being placed on a perforated shelf over water near its boiling point, the whole being contained in a closed vessel.

In either case the pods are afterwards immediately transferred (after being allowed to drain for a few moments, and while still hot) to sweating boxes similar to those already described. They are then exposed in the sun for

6–8 days until they reach the proper condition, and are finally allowed to dry slowly in the shade in a well-ventilated drying house.

Less elaborate methods are used in other countries. Thus in Peru the pods are immersed in boiling water and hung up to dry in the open air. After drying for some 20 days they are smeared with castor oil and tied up in bundles.

Imperial Institute Publications on Mineral Resources.—A new volume in this series, *Beryllium (Glucinum) and Beryl*, has recently been issued by H.M. Stationery Office (26 pp., price 6*d*.).

The demand for new metals and alloys of very light weight, but strong and resistant to corrosion, for use in the rapidly expanding aircraft and automobile industries has caused much interest to be taken in beryllium. It is a metal much lighter than aluminium, with high melting point, high modulus of elasticity and considerable tensile strength. It forms an interesting series of alloys with aluminium, copper, iron and nickel, and imparts valuable properties to certain steels.

The monograph describes briefly the methods of preparing the metal, which are complex and expensive, the alloys which have been prepared and studied, and gives the latest information regarding production and prices. It also describes the known deposits of beryl, which is the only ore of the metal, special consideration being given to those within the Empire, concluding with a bibliography.

At present the only producers of metallic beryllium and alloys are in Germany and the United States, but the British Empire is in a strong position in regard to this metal if only adequate financial resources can be found to follow up the work of its own scientific investigators and mineral explorers, who have already provided much of the basic knowledge required.

China-clay (Kaolin).—Another monograph, on China-clay, was issued early in January 1932 by H.M. Stationery Office (100 pp., price 1*s*. 6*d*.).

China-clay, also known as kaolin, has been employed for centuries as one of the chief ingredients of body-mixes for the manufacture of pottery, but it is not generally known that only about one-third of the total production of the material is now utilised for this purpose, by far the largest proportion being used in the paper industry. The uses of china-clay, however, are numerous, and not the least interesting are the medicinal, pharmaceutical and toilet preparations made from this material. These and many other interesting facts have been brought together in the new publication which deals succinctly, yet comprehensively, with the nature and origin of the mineral, and its occurrence in over forty British and foreign countries. Consideration is also given to the methods employed for the winning and treatment of the raw material with special reference to modern improvements in technique, trade classification of the prepared clay, uses, prices, together with statistical information regarding production, imports and exports. The section on the actual and potential utilisation of waste products is of particular interest, since it has been estimated that in Cornwall alone some four million tons of waste material are annually taken to the dumps, which form such a characteristic feature of the clay districts. The work concludes with a classified bibliography covering all aspects of the subject.

An up-to-date monograph on the world's resources of china-clay has been long overdue, and the present work seeks to meet this need.

Mining Laws of the British Empire—New Zealand.—The Imperial Institute has just published a new volume in the series entitled the *Mining Laws of the British Empire, Vol. X, New Zealand* (H.M. Stationery Office, London, price 30*s*.). In accordance with the now familiar arrangement, Part I consists of a General Analysis of the laws and regulations and contains chapters on the Miner's Right, Prospecting, Claims, Leases (Coal and Oil), Forfeiture, Abandonment and Protection, Ancillary Rights, Registration, Fees, Rents and Royalties, and Machinery for Settlement of Disputes.

Part II consists of the text of the Mining Act, 1926 (as amended by the Mining Amendment Act, 1927), the Regulations under the Mining Act, 1926, the Coal Mines Act, 1925 (as amended by the Coal Mines Amendment Act, 1927), extracts from the Regulations under the Coal Mines Act, 1925, and the Coal Mines Amendment Act, 1927.

An introductory chapter traces the history of mining legislation in New Zealand from the first statutes passed a few years after the first notification of the discovery of gold in 1851.

Mineral Statistics.—The 1928–1930 edition of the Imperial Institute Annual Statistical Summary ("The Mineral Industry of the British Empire and Foreign Countries") was published recently by H.M. Stationery

Office (price 5*s.* 6*d.*) and contains, as usual, the production and trade figures for forty-eight minerals, of which about one-half are metallic.

The "Crown Colonist."—This new periodical is described as "a monthly journal of information for all concerned in the trade and development of British East and West Africa, the West Indies, Ceylon, Malaya, and the other Colonies, Protectorates and Mandated Territories of the Empire." It is mentioned by the publishers that no authoritative and technically competent journal at present exists which has for its special concern the trade and industry, public services and private enterprises, growth and economic development of all the Colonies, their relations with one another and the rest of the Empire, and especially with Great Britain. The "Crown Colonist" aims at fulfilling this function, and the first number, which has recently been issued, shows great promise in this direction. It contains a number of features likely to appeal widely to the various Colonial interests, commercial and otherwise. Much useful summarised information on trading and industrial development is given, and special articles on a variety of subjects.

The "Crown Colonist" is published at 33, Tothill Street, Westminster, S.W.1, price 1*s.* per copy, or 12*s.* per annum post free.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

Cover Crops

Leeward Islands. *Montserrat.*—According to the half-yearly report on the Experiment Station, Montserrat, for the period ended June 30, 1931, the following cover crops, obtained from the Imperial College of Tropical Agriculture, Trinidad, have been tried and proved most successful as low covers: *Calopogonium mucunoides, Centrosema pubescens, Pueraria javanica.*

Crotalaria juncea proved most successful as a very quick-growing crop and, in the opinion of the Acting Curator, would be an excellent thing where a quick-growing temporary wind break for young seedlings is required. It must, however, be planted fairly thickly.

Uganda.—The half-yearly report on the Serere Experiment Station for the period ending June 30, 1931, contains the following notes on cover crops under trial at the Station.

Dolichos Lablab.—Two one-quarter acre plots were sown on April 21 for the maintenance of stock, spacing 2 ft. × 1½ ft. The plants had reached the flowering stage by the middle of June.

A leaf disease is rather common, easily seen by its rusty-looking appearance, and curling of the leaves and unhealthy colour. At the time of writing, the cause of the disease had not been determined.

Dolichos Lablab is the best autumn cover crop for local conditions, possibly on account of it requiring less rain. It is, however, subject to attack by flower-eating beetles at all times.

Sword Bean (*Canavalia ensiformis*).—The area under this crop is similar to the above. It was sown at the same time and is also being grown for the production of seed. Spacing distance 2 ft. each way.

Flowering took place profusely in mid-June.

This is the best all-round cover crop at the Station for both spring and autumn use.

Crotalaria striata.—One ten-acre block is under this plant for standing the remainder of the year, as a means of economy. It was sown on May 4, seed rate 14 lb. per acre. This seed rate appears ample when used as stated, which is primarily to provide seed, but is insufficient if grown as a cover in the usual sense of the word. Fully 40 lb. is then needed as growth is rather slow in the early stages, weeds getting the upper hand otherwise.

Crotalaria alata.—This is a new introduction during the year from Masindi (Uganda). It is one of the small-seeded species and one which germinates very slowly.

As only a small quantity of seed was available it was decided to try plots with varying seed rates. Three were put down, seed rates used being equivalent to 12 lb., 16 lb. and 20 lb. per acre. All these proved far too small for use as a cover so the remainder was sown at the rate of 42 lb. per acre. This seems as if it might be nearer what is required.

This may prove suitable as a cover crop in the later stages, but it is very slow-growing at first, and very slow-germinating.

Sunn Hemp (*Crotalaria juncea*).—This looks particularly suitable for a cover crop on account of its very rapid germination and subsequent growth. The obtaining of sufficient seed for this purpose is being aimed at.

Soya Beans (*Glycine hispida*).—A block of ten acres was sown during the third week in March, with a seed rate of 50 lb. per acre. It was intended for cover only, but one acre had to be retained for seed on account of plots elsewhere being partially destroyed by "hoppers." A yield of 527 lb. of seed was harvested at the beginning of June.

Centrosema pubescens.—A small plot of this plant has been under trial since the early part of last year. Nothing definite has yet been achieved. The plants were practically denuded of foliage during the dry season, being almost dried up. Since the rains fairly rapid recovery has been made and at times a considerable quantity of flowers produced.

Very little seed has been obtained so far for further propagation, on account of the abundance of flower-eating beetles.

Indigofera sp.—A small plot of one of the more promising species of indigenous *Indigofera* has been sown with a view to trying it out as a cover crop, but plants are rather sparse owing to very poor germination.

INSECT PESTS

Locusts

Nigeria.—Mr. F. D. Golding, Senior Entomologist, Department of Agriculture, reports that during the first six months of 1931, the whole of his time was devoted to the locust problem, either in assisting in the organisation of the campaign or in carrying out experimental work.

During January and February the majority of flying swarms of *Locusta migratoria migratorioides*, R. and F., were confined to the Southern Provinces; with the onset of the rains in March a northerly movement commenced. By the end of March the Southern Provinces were free from flying swarms and, apart from a few bands on the Oyo-Ilorin border, escaped the subsequent hopper infestation. Evidence was obtained that a number of swarms disintegrated and died before reaching sexual maturity; dissection of dead individuals did not yield a clue as to the causal factor.

Hopper Campaign.—During the latter part of March and the month of April a few hopper bands appeared in several of the Northern Provinces; the infestation increased considerably during May and by the end of June all the Northern Provinces were affected. The anti-hopper campaign, organised by the Assistant Director of

Agriculture, Northern Provinces, was very successful, large quantities of poison bait being used with excellent results. The principal substances utilised as bases in the manufacture of bait were sawdust and bran or chaff derived from various cereal crops, while sodium arsenite was used exclusively as the poison ; the bait was prepared by the " wet " method and contained about 2·4 per cent. of poison.

The first swarms of adults of the new generation were reported in the second week of June—about one month later than in the previous year—and, as in 1930, the general flight direction of the daughter swarms had been to the north-east.

Experimental Work.—The principal problems which required elucidation were the desirability of substituting sodium fluosilicate for sodium arsenite as a hopper-poison and the determination of the suitability of various bases for the preparation of poisoned bait.

(*a*) During a recent campaign in India against the hoppers of the Desert Locust, sodium fluosilicate was found to be an efficient substitute for sodium arsenite, which was regarded with disfavour on account of its toxicity to mammals. The fluosilicate was mixed dry with bran and either salt or molasses was added as an attractant ; the bait was moistened with water before being applied to the hopper bands.

As a result of field experiments the writer has found that sodium fluosilicate is an effective poison against the hoppers of *L. migratorioides*, but is not as rapid in its action as sodium arsenite ; this was confirmed by laboratory experiments with individual hoppers fed on baits containing identical quantities of the two poisons, viz. 2·44 per cent. The average period between feeding and death was about two and a half times longer for fluosilicate than arsenite. The question of rapidity is of some importance as a quick-acting bait allows an anti-locust officer to see some result from his labour before he moves to another locality.

It was found unnecessary to add an attractant to the fluosilicate bait.

(*b*) The bases in common use in Nigeria are sawdust and the bran and chaff from various cereals ; the supply of sawdust is limited and, in certain localities, cereal bases are unobtainable in sufficient quantities. The writer obtained satisfactory results with chopped hay mixed either with fluosilicate or arsenite. He also found that newspaper, torn into pieces with a superficial area of about 2 square inches, promised to be a satisfactory base, but he has not yet had an opportunity of testing this substance in the field.

SUGAR

Cane

Leeward Islands. *Antigua.*—According to the report on the work of the Agricultural Department, Antigua, for the half-year ending June 30, 1931, the work in connection with Gumming Disease was continued. The following note indicates the results obtained.

Mr. Illingworth, who was seconded for investigation of Gumming Disease during the period May 1929–March 1930, planned and laid down at Skerretts an experiment devised to indicate whether the apparently greater resistance shown by ratoons and more particularly second ratoons could be explained on the theory that ratoons acquired a degree of immunity which could be transmitted to plant canes propagated from such ratoons.

Thirteen rows were planted, four with cuttings from plant canes of B 11569, four with cuttings from first ratoons of this variety and five with cabbage plants; the arrangement of the rows being entirely at random.

Growth was slow owing to the dry weather and up to the end of October leaf lesions were not observed. By the middle of February leaf contacts became general and lesions appeared, though not to the extent observed in fields of this variety in previous seasons.

Twenty-five canes from each row were cut, divided into sections (cabbage, first quarter, second quarter, third quarter and base) and these sections were incubated for twenty-four hours. Only one globule of gum was observed—this occurred on the second quarter of a cane grown from the cabbage plant of a second ratoon.

Conditions were unfavourable for the development of gumming and the result of the experiment therefore conveys no information on the point in question.

The Moth Borer (*Diatrea saccharalis*) is by far the most important pest of sugar-cane in Antigua. During the month of April 1930 Dr. J. G. Myers of the Imperial Bureau of Entomology introduced the parasitic Tachinid fly (*Dixophaga diatreæ*) from Cuba where it effectively controls this pest. Thanks to a grant from the Colonial Development Fund, Mr. H. E. Box has been appointed as resident entomologist for a period of three years generally to investigate the ecology of Diatrea.

FRUITS

Citrus

Leeward Islands. *Dominica.*—The following statement summarises progress made with the investigational work carried out by the Agricultural Department, Dominica, during the half-year ended June 30, 1931.

1. Efforts to obtain a "hybrid lime" with suitable marketing qualities and immune to Withertip disease of limes (*Glœosporium limetticolum*). The most promising four-year-old hybrids were back-crossed with pollen taken from the West Indian Lime. Flowers of the following crosses were successfully pollinated:

Woglum Lime × West Indian Lime . .	13
Citrus Aurantifolia Lime × West Indian Lime .	16

2. *Lime Experiment Station.*

The Seedling Limes under manurial experiments having been almost completely destroyed by root disease and hurricanes, replanting, which had already commenced before the hurricane, has been continued on a more extensive scale, with the following chief objects in view:

(1) Trials of stocks for comparison with the Sour Orange.
(2) Distance trials in varying situations.
(3) Demonstrations in the planting and management of budded citrus.
(4) Cover crop trials in conjunction with the above.
(5) An extension of the collection of varieties of Oranges, Grapefruits and Lemons not already adequately represented.

The original *nine* quarter-acre plots numbered 13–21 which formed part of the manurial experiments were converted into *three* series, viz. A, B, C, each consisting of three plots planted thus: (1) Limes on Sour Orange, (2) Limes on Rough Lemon and (3) Limes on Grapefruit.

Prior to the new system of planting, the plots were: (1) cleared of disease-ridden seedlings, (2) hoed, drains cleared, holes dug, and (3) sown with horse beans (*Canavalia ensiformis*). In A and C the alternate system of planting was adopted 20 ft. × 20 ft. apart.

3. *Other Experimental Plantings of Limes.*

Three and a half acres of land unsuitable for the siting of accurate parallel plots were planted, partly for the purposes of revenue, but mainly with the intention of experiment.

(1) Comparison between limes budded and grafted on the sour orange.

Situation.—" Old Lime " Piece—44 plants planted 20 ft. × 20 ft. grafted.

" Old Lime " Piece—47 plants planted 20 ft. × 20 ft. budded.

(2) *Planting Distances.*

Situation.—" *Jack's Well.*" 66 plants planted 25 ft. × 25 ft.

It is intended to plant a similar area at reduced distances.

(3) *Trial of Seedless Lime.*—Discovered by Mr. H. D. Shillingford.

Situation.—*Plot* 12. Planted 20 on grapefruit stocks 20 ft. × 25 ft.

(4) *Mulch Grass Experiments.*

Situation.—" *Martin's Field.*" (1) 71 plants 20 ft. × 20 ft. grafted, intersown with horse beans. (2) 73 plants 20 ft. × 20 ft. grafted. Approximately half planted with Lemon grass (*Cymbopogon citratus*) and half planted with Vetiver (*Vetiveria Zizanioides*), in the following way. The grass is planted about 18 in. from the edges of the drain which runs midway parallel to the rows of trees, and a clump of grass alternately planted between them. *Tephrosia candida* is sown in the intervening space, leaving the tree clear in a diameter of 8 ft.

Citrus stock trials are being arranged for in the Northern and Eastern Districts.

Leeward Islands. *Montserrat.*—Large-scale grafting of lemon and limes on sour orange stocks was continued at the Experiment Station, Montserrat, during the first half of 1931. On the advice of the Agricultural Assistant grafting is being done at least 12 in. above the soil, as Gummosis is avoided to a large extent in this way. Prior to this the union was being made somewhat on the low side, viz. from 4 to 6 in. above the soil.

Tomatoes

Leeward Islands. *Antigua.*—The following account of experimental work on tomatoes carried out in Antigua is taken from the half-yearly report on the Department of Agriculture for the period ending June 30, 1931.

Four varieties were grown, viz. Bonny Best (Peter Henderson), Sutton's Earliest of All, Sutton's Open Air and a Cross ES, obtained from Cheshunt.

The tomatoes were planted at intervals of 2 ft. in banks 3 ft. apart : all plants were staked and pruned to a single stem.

The plants were raised in seed beds, transplanted to nursery beds at 5 in. × 5 in. and set in the field from about the middle of November until early in December. Caterpillars were troublesome but were controlled by hand picking and dusting with a Paris Green Lime mixture 1 : 8 and the plants made excellent growth and promised a good crop. Continued drought [1] however, and the leaf fungus caused by *Cladosporium fulvum* (favoured by cold damp nights despite the drought) did considerable damage and the yields were very poor—one part of the plot, on rather higher and lighter soil than the remainder and planted somewhat later, yielding nothing at all.

The areas planted under the various varieties, the yields actually obtained and the calculated yields per acre are shown in the following table :

Variety.	Area Planted.	Actual Yield.	Calculated Yield per acre.
	sq. ft.	*lb.*	*lb.*
Bonny Best	17,818	1,442	3,520
Best of All	1,600	403	11,000
Open Air	1,200	249	9,050
ES	1,600	299	8,150

The three English varieties were much heavier yielders than Bonny Best, were uniform in shape and with one exception (ES) free from growth cracks, but unfortunately they were usually too small for the Canadian market, comparatively few of the fruits being large enough for shipment and these falling into the "gem" grade.

FIBRES

Cotton

Uganda.—According to a report on the Bukalasa Experiment Station for the first half-year of 1931, the experimental work on cotton has been confined chiefly to cultural experiments, namely : sowing date and spacing, sub-soiling, mulching, ridging, lime and green manure, crop residue, and interplanting experiments and a "blackarm" experiment.

Sowing and Spacing Experiment.—An experiment designed to find the optimum sowing date and spacing for this area. Three sowing dates, mid-June, mid-July and mid-August, and four spacings, 4 ft. × 2 ft., 3 ft. × 2 ft., 4 ft. × 1 ft., and 3 ft. × 1 ft., were tested in this experiment and the results obtained indicate that the optimum for Bukalasa of these sowing dates is mid-June and that the optimum spacing at all sowing dates is 3 ft. × 1 ft.

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[1] Rainfall from December 1–March 31, 5·32 in.

Sub-soiling Experiment.—The sub-soil in most of the area under cultivation at Bukalasa is a stiff clay, which cotton roots are unable to penetrate, thus cotton almost invariably develops a twisted taproot. A two-acre plot was divided into twenty-four strips, half of which were sub-soiled and the remainder used as controls, and cotton was grown on all the strips. It was found that cotton on the sub-soiled plots produced longer taproots and that the percentage of twisted roots was only 33 per cent. compared with 57 per cent. on the control plots. A significantly greater yield was obtained from the sub-soil plots.

Ridging Experiment.—This experiment was designed to find out whether planting on ridges has any effect on the yield of cotton, but no significant results were obtained.

Interplanting Experiment.—It is the common practice in Buganda Province for native cultivators to interplant their cotton with beans and ground-nuts, and in order to find out whether this interplanting has any adverse effect on the yield of cotton an experiment was designed including interplanting, at the time of sowing of the cotton and also one month later, with both beans and ground-nuts. The interplanted plots in all cases gave significantly lower yields than the control plots, but with the later interplanting there was less difference. The cotton was planted rather late and the season was exceptionally dry, thus water deficiency may have been the biggest limiting factor in the interplanted plots.

Mulching.—An attempt to find out whether mulching with elephant grass has any effect on the yield of cotton. The mulched plots, on which elephant grass was put to the depth of 3 to 6 in., gave higher yields of cotton, but results as worked out by Fisher's method were not significant owing to insufficient repetitions.

Lime and Green Manure Experiment.—An experiment designed to determine the effect on the yield of cotton of liming, and of liming and green manuring combined. One-third of the plots are green manured with *Crotalaria juncea*, grown in the April rains, while lime is applied at the rate of 1 ton per acre in June to these plots and to half the remaining plots. The results show that green manuring and liming gives a significantly greater yield than liming alone, but the difference in yield between the former treatment and the control was not significant.

Crop Residue Experiment.—An experiment designed to find the effect on the soil of growing various food crops. The food crops chosen were maize, ground-nuts, beans, simsim and sweet potatoes, and these are grown on the same plots year after year, while the effect is measured by the yields of cotton taken off these plots every second season, namely, planted in July each year. The yields obtained from cotton in the 1930-31 season show a marked significant difference in favour of cotton grown after sweet potatoes. This may be due to the more thorough cultivation of the soil when the potato crop was harvested.

Blackarm Experiment.—An experiment designed to find out to what extent blackarm infection is carried on the seed. Seed from two " clean " areas, and seed from four infected areas was planted in a latin square. Unfortunately the weather conditions were unfavourable for the development of blackarm and practically none was observed. The only result obtained from the experiment was that the seed from one of the " clean " areas gave a much higher germination count than that from the infected areas, probably due to the greater percentage of " light " seed in the samples obtained from the infected areas.

Sunn Hemp

Uganda.—According to a report on the work of the Serere Experiment Station for the first half-year of 1931, seed of Sunn hemp (*Crotalaria juncea*) was first introduced to the Station towards the end of last year from Bukalasa (Uganda) but too late for sowing on account of the approaching dry season, which is general from November till March. Early this year other small samples (5 lb.) were received from both Nagpur and Cawnpore, India.

Sufficient of the Bukalasa seed was received to plant up 2½ acres in all. Experiments are being tried with various seed rates, viz. 40 lb., 50 lb. and 60 lb. per acre, to note if any appreciable difference is shown in the length of fibre from such plantings. There are four repetitions of the two lower seed rates and three only of the higher one.

Sowing was carried out on April 15. The germination which resulted was remarkably rapid (mostly within three days of the sowing date) and plants reached the flowering stage well within six weeks of sowing. Growth generally during this period was extremely variable in height (anything from 2 ft.–4½ ft. at the time of the first flowers) and so showed up soil variation rather well. At the end of June plants were flowering very profusely.

Three cuttings during the season are to be made for fibre extraction, roughly, one at the early flowering stage, the second when flowering has finished, and the last when the fruits are ripening. So far, only the results of the first cutting, made on June 8, are available. The results were disappointing, only 4 oz. of fibre of varying length being obtained from 1/80 acre, which suggests that this cutting was made too soon, and before the fibres had formed.

In the case of both the Nagpur and the Cawnpore strains, the plants are much more dwarf, and less vigorous, than plants from the acclimatised seed. Both types are being grown for the increase of stock and subsequent selection.

OIL SEEDS

Ground-nuts

Uganda.—The report on the Bukalasa Experiment Station for the first half-year, 1931, states that a spacing experiment with the bunch type of ground-nuts, testing the following spacings, 2 ft. × 2 ft., 2 ft. × 1 ft., 1½ ft. × 1 ft., and 1 ft. × 1 ft., resulted in the closest spacing giving a significantly greater yield than any of the others; there was no significant difference between 2 ft. × 1 ft., and 1½ ft. × 1 ft. spacings but both these gave significantly greater yields than the 2 ft. × 2 ft. spacing.

In a ridging experiment of ground-nuts there was no significant difference between ground-nuts grown on the ridges and those grown on the flat.

Sesame Seed

Uganda.—The report of the Serere Experiment Station for the half-year ending June 30, 1931, states that roughly 11 acres are under Simsim (*Sesamum indicum*), mostly in small plot formation. Two experiments are included, a sowing date and rate of seeding trial, and a variety trial.

The sowing date and rate of seeding trial is on exactly the same lines as that of last year, the first sowing being made a day later than that of 1930.

Excellent growing conditions were experienced up till the end of May, after which a dry spell continued until mid-June. Aphis became abundant in consequence, an abnormal amount of malformation of flowers and stunted growth in the later sown plots occurred, and the appearance of the plots deteriorated greatly. So much so that it can safely be said that all later sowings will be a complete failure. In addition to Aphis damage the "gingelly fly" was largely responsible from that time and later on.

Leaf disease (*Cercospora sesami*) also appeared in large quantities about flowering time, and a little later not a few plants went under to the attacks of *Rhizoctonia* sp.

A very light crop only is anticipated, the depression in yield increasing as the sowings became later.

The variety trial includes the trying-out of selected seed, ordinary seed, and seed purchased locally. Seed was sown on April 18, at the rate of 10 lb. to the acre, there being eight repetitions of the three kinds of seed.

As in the case of the preceding trial a very light yield only is anticipated owing to similar conditions.

The report of the Bukalasa Experiment Station for the same period states that the native practice is to broadcast simsim and to sow it much too thickly. In order to find the optimum spacing, an experiment was made with simsim at the following spacings : 2 ft. × 2 ft., 2 ft. × 1 ft., 1 ft. × 1 ft., and 1 ft. × ½ ft. The stand of plants was irregular and most were attacked by *Cercospora sesami*. The results showed that the 2 ft. × 2 ft. spacings have a significantly smaller yield than the other spacings, while 2 ft. × 1 ft. and 1 ft. × 1 ft. gave slightly larger yields than 1 ft. × ½ ft. spacing, but this difference was not significant.

Shea Nuts

Uganda.—According to the report of the Serere Experiment Station for the first six months of 1931 an experiment with the planting of Shea nuts (*Butyrospermum Parkii*) has been commenced there. Acting upon recommendation of Messrs. Lever's representative during a recent visit to the Station, between 7 and 8 acres have been planted up with locally collected material, seeds and seedlings. Planting was done during April.

Two spacings are being tried, 50 ft. × 50 ft., and 30 ft. × 12 ft. 6 in. The latter allows for the cutting of alternate trees when overcrowding occurs.

An experiment with seeds and seedlings was taken into account at the time of planting, alternate rows of each. Only a small percentage of the seedlings seem to have responded happily to transplanting, presumably on account of the very long taproot usually possessed.

Observations at the time of lifting seedlings showed that plants with a comparatively small amount of top growth (4–5 leaves, the largest about 3½ in. long) frequently had a taproot fully 1 ft. 6 in. in length and so on in proportion. Root hairs were particularly scarce.

These facts were borne out in the nursery also, seeds often had the formation of a taproot fully 6 in. long before any signs of a plumule existed.

On account of this the sowing of seeds in their final quarters is to be advised, but it is absolutely essential that freshly collected seed be used to get a good stand of plants.

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Studies on the Chemistry of Grape Juice. By E. L. Green and Z. I. Kertesz. *Tech. Bull. No.* 181, *New York State Agric. Exper. Sta., Geneva.* Pp. 14, 8¾ × 5¾. (Geneva, N.Y.: 1931.)

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Habits and Control of the Coconut Black Beetle (*Oryctes rhinoceros* L.). By C. N. E. J. de Mel. *Trop. Agric., Ceylon* (1931, **77**, 99–111).

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Le Sisal en Afrique du Nord. By M. F. Michotte. *Agric. Prat. des Pays Chauds* (1931, **2**, 687–690). The possibility of sisal cultivation in North Africa.

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Annual Report, 1930, of the Rubber Research Institute, of Malaya. Pp. 134, 9¾ × 6½. (Kuala Lumpur: Rubber Research Institute, 1930.) Price $1.

Diseases of Rubber in Ceylon. By R. K. S. Murray. Pp. 44, 9½ × 6½. (Ceylon: Rubber Research Scheme, 1931.) Deals with a large number of diseases of rubber, describing them, giving an account of the symptoms and methods of control, and in addition deals with diseases and pests of plants associated with rubber in its cultivation. The publication is divided into the following sections: Root and collar diseases, stem diseases, leaf diseases, diseases and pests of nursery plants and diseases and pests of cover crops.

The Curing of Sheet Rubber. By T. E. H. O'Brien. *Bull. No.* 51, *Rubber Research Scheme, Ceylon.* Pp. 34, 8½ × 5½. (Peradeniya, 1930.) Comprises (1) a reprint of a paper read at the Agricultural Conference, Peradeniya, October 1930, on a method that has been devised for the preparation of standard quality smoked sheet on estates where firewood consumption has to be reduced to a minimum, and (2) reports on the examination by officers of the Scheme at the Imperial Institute of samples prepared in connection with the investigation of the method, on the effect of drying sheet rubber partially at ordinary temperature and partially at 100° F., on the effect of paranitrophenol on the ageing properties of vulcanised sheet rubber and on the effect of curing sheet rubber over a coke fire.

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Report on the Tobacco Position in Great Britain. By J. W. Downie. *Rhodesia Agric. Journ.* (1931, **28**, 798–806). The consumption of tobacco in Great Britain with special reference to Rhodesian leaf.

Report of the Officer in Charge of the Tobacco Division, Department of Agriculture, Canada, for the Year 1930. Pp. 26, 9¾ × 6½. (Ottawa: King's Printer, 1931.)

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Bright Tobacco. By N. A. R. Pollock. *Queensland Agric. Journ.* (1931, **36**, 149–183). A comprehensive article dealing with all aspects of the production of bright tobacco, from the seed-bed to packing.

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Tobacco Pests. By J. H. Smith. *Queensland Agric. Journ.* (1931, **36**, 195–212). A full description of the more important pests and their control.

Tobacco Diseases. By L. F. Mandelson. *Queensland Agric. Journ.* (1931, **36**, 213–233). Gives descriptions of the more important diseases, the symptoms, causes and suggested methods of control.

Hints on Combating Tobacco Diseases. By E. S. Moore. *Farming in S. Africa* (1931, **6**, 185–187).

Fireblight and Its Control. By G. H. Cunningham. *New Zealand Journ. Agric.* (1931, **43**, 111–118). The occurrence, description and control of the disease in New Zealand.

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"Downy Mildew" (so-called "Blue Mould") of Tobacco. The Industry's Most Serious Menace, and How to Combat it. By H. A. Puttman. *Journ. Dept. Agric., W. Australia* (1931, **8**, 264–272).

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Moss Peat, Its Uses and Distribution in the United States. By A. P. Dachnowski-Stokes. *Circ. No.* 167, *U.S. Dept. Agric.* Pp. 11, 9¼ × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1931.) Price 5 cents.

Live-stock and Animal Products

Report on the Marketing of Sheep, Mutton and Lamb in England and Wales. *Econ. Series No.* 29, *Min. Agric. and Fisheries.* Pp. 186, 9¾ × 6. (London: H.M. Stationery Office, 1931.) Price 6*d.* The results of a detailed investigation of the marketing of sheep and lambs, both store and fat, and of mutton and lamb in England and Wales.

Veterinary Research Report No. 6, Department of Agriculture, New South Wales. Parts I and II. By H. R. Seddon. Pp. 91, 9½ × 6. (Sydney: Government Printer, 1931.)

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Report on the Cattle-breeding Operations in the Central Provinces and Berar for the Year ending March 31, 1930. Pp. 58, 9¾ × 6¼. (Nagpur: Government Press, 1930.) Price 1 rupee.

Annual Report of the Live-stock Research Station, Chintaladevi, Madras, for the Year 1929–30. Pp. 13, 9½ × 6. (Madras: Superintendent, Government Press, 1931.)

Annual Report of the Department of Veterinary Science and Animal Husbandry, Tanganyika Territory, for 1930. Pp. 60, 13 × 8. (Dar es Salaam: Government Printer, 1931.) Price 5*s*.

Economic Position of the Dairy Industry. A Brief Survey of Present Conditions in New Zealand. By E. J. Fawcett. *New Zealand Journ. Agric.* (1931, **42**, 377–384). An article based on the evidence given by the writer before the Industrial Arbitration Court at Wellington.

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The Angora Goat Industry of Oregon. By O. M. Nelson. *Bull.* 289, *Oregon Agric. Exper. Sta.* Pp. 27, 9 × 6. (Corvallis: State Agricultural College, 1931.) Mainly an economic survey of the industry, with a short section on flock management on the farms visited.

La Domestication de l'Eléphant au Congo Belge. By C. Huffmann. *Bull. Agric., Congo Belge* (1931, **22**, 3–22).

Marketing Poultry. By R. B. Slocum. *Farmers' Bull. No.* 1377 (*Revised*), *U.S. Dept. Agric.* Pp. 32, 9½ × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1931.) Price 5 cents.

Bee-keeping in Missouri. By L. Haseman. *Bull.* 305, *Missouri Agric. Exper. Sta.* Pp. 52, 9 × 6. (Columbia, Missouri: College of Agriculture, 1931.)

Report on Sea Fisheries, England and Wales, by the Ministry of Agriculture and Fisheries, for the Year 1930. Pp. 81, 9½ × 6. (London: H.M. Stationery Office, 1931.) Price 1*s*. 3*d*.

Forty-Ninth Annual Report of the Fishery Board for Scotland, being for the Year 1930. Pp. 93, 9¾ × 6. (London: H.M. Stationery Office, 1931.) Price 1*s*. 6*d*.

Report on the Fisheries of Egypt for the Year 1929. Pp. 92, 11 × 7¾. (Cairo: Government Press, 1931.) Price P.T. 5.

The Fishing Industry of Malta with Suggestions for its Further Development. By J. Hornell. Pp. 62, 8¾ × 6. (Malta: Government Printing Office, 1931.) Price 9*d*.

Industrial Shells of the Philippines. By F. Talavera and L. A. Faustino. *Philippine Journ. Sci.* (1931, **45**, 321–350). Description, occurrence, industry and utilisation of the following shells: gold-lip pearl, black-lip pearl, trochus, turban, window and chambered nautilus shells.

FORESTRY

General

Eleventh Annual Report of the Forestry Commissioners, Year ending Sept. 30, 1930. Pp. 38, 9½ × 6. (London: H.M. Stationery Office, 1931.) Price 9*d*.

Welsh Timber Trees, Native and Introduced. By H. A. Hyde. *Publication of the National Museum of Wales.* Pp. 107, 8½ × 5½. (Cardiff: National Museum of Wales, 1931.) Price 1*s*. Descriptions of the chief timber trees grown in Wales and their uses, preceded by a general account of Welsh forestry. The publication is well illustrated with twenty-five plates and twenty-one diagrams. There is also a bibliography of 95 references.

Annual Report of the Division of Forest Products, Council for Scientific and Industrial Research, Australia, for 1930–31. Pp. 17, 13¼ × 8¼. 1931. Mimeographed copy.

Report of the Forest Trust, British Honduras, for 1930. Pp. 15, 13 × 8¼. (Belize: Clarion Ltd., 1931.)

The Lumber Industry, Dominion of Canada, 1928–29. A Census of the Industry prepared by the Dominion Bureau of Statistics. Pp. 89, 9½ × 6½. (Ottawa: King's Printer, 1931.) Price 25 cents. In English and French.

Report on the Forestry Department, Gold Coast Colony, for the Year 1930–31. Pp. 15, 13 × 8½. (Accra: Government Printing Office, 1931.) Price 2*s*.

Report on Forest Administration in the Andamans for the Year 1929–30. Pp. 85, 9¾ × 6½. (Calcutta: Government of India Central Publication Branch, 1931.) Price Rs. 10 As. 12 or 17*s*. 6*d*.

Annual Progress Report on Forest Administration in the Presidency of Bengal for the Year 1929–30. Pp. 125, 9¾ × 6¼. (Calcutta: Bengal Secretariat Book Depot, 1931.) Price Rs. 4–8 or 7*s*. 6*d*.

Annual Progress Report on Forest Administration in the Province of Bihar and Orissa for the Year 1929–30. Pp. 72, 13¼ × 8½. (Patna: Superintendent, Government Printing, 1930.) Price Rs. 3.

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Growth of Malayan Forest Trees as Shown by Sample Plot Records, 1915–1928. By J. P. Edwards. *Malayan Forest Record, No.* 9. Pp. 151, 10¼ × 7½. (Kuala Lumpur: Director of Forestry, 1930.) Price $2 or 4*s*. 6*d*.

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Annual Report of the Forest Department, Sierra Leone, for the Year 1930. Pp. 4, 13 × 8¼. (Freetown: Government Printer, 1931.) Price 2*s*. 6*d*.

Administration Report of the Conservator, Forest Department, Trinidad and Tobago, for the Year 1930. Pp. 22, 13½ × 8½. (Port-of-Spain: Government Printer, 1931.) Price 1*s*.

Forest Types in the Southwest as Determined by Climate and Soil. By G. A. Pearson. *Tech. Bull. No.* 247, *U.S. Dept. Agric.* Pp. 144, 9¼ × 5¾. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1931.) Price 30 cents.

Lumber Production in Ohio. By R. R. Paton. Damage to Lumber Caused by Insects. *Bull.* 478, *Ohio Agric. Exper. Sta.* Pp. 46, 9 × 6. (Wooster: Agricultural Experiment Station, 1931.)

Timber Growing and Logging Practice in the Southern Appalachian Region. By E. H. Frothingham and R. Y. Stuart. *Tech. Bull. No.* 250, *U.S. Dept. Agric.* Pp. 93, 9 × 5¾. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1930.) Price 30 cents.

The Cypresses. By W. Dallimore. *Empire For. Journ.* (1931, **10**, 37–47). Description of the genus *Cupressus* and the more important species.

Philippine Dao (*Dracontomelum dao*). By G. A. Garratt. *Trop. Woods* (1931, No. 27, 1–11). A description of the tree, the wood, its botanical and physical properties and its utilisation. There are in addition some notes on other species of *Dracontomelum*.

Quelques Légumineuses de la Côte d'Ivoire à Bois Utilisable. By A. Chevalier and D. Normand. *Rev. Bot. Appl. et d'Agric. Trop.* (1931, **11**, 397–409; 569–577).

A Note on Burmese Lagerstrœmias. By C. E. Parkinson. *Burma Forest Bull. No.* 23. (Rangoon: Superintendent, Government Printing and Stationery, 1931.) Price Rs. 1–8 or 2*s*. 3*d*. This bulletin is drawn up as a means of identifying the various species; descriptions of the plants, their leaves and flowers are given, together with other particulars.

Shortleaf Pine (*Pinus echinata*). By W. R. Mattoon. *Farmers' Bull.* 1671, *U.S. Dept. Agric.* Pp. 43, 9½ × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1931.) Price 10 cents. A revision of *Farmers' Bull. No.* 1534, "Shortleaf Pine Primer."

Slash Pine (*Pinus caribœa*). By W. R. Mattoon. *Farmers' Bull. No.* 1256 (*Revised*), *U.S. Dept. Agric.* Pp. 52, 9½ × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1931.) Price 10 cents.

Timbers

The Density of Australian Timbers. A Preliminary Study. (Division of Forest Products. Technical Paper No. 2.) By H. E. Dadswell. *Pamphlet No.* 21, *Counc. Sci. Indust. Res., Australia.* Pp. 16, 9½ × 6. (Melbourne: Government Printer, 1931.) Describes a new method of determining the density of timber and some of the results obtained by its use.

The Chemistry of Australian Timbers. Part I. A Study of the Lignin Determination. (Division of Forest Products. Technical Paper No. 3). By W. E. Cohen and H. E. Dadswell. *Pamphlet No.* 22, *Counc. Sci. Indust. Res., Australia.* Pp. 27, 9½ × 6. (Melbourne: Government Printer, 1931.)

A Comparison of the Timbers of Burma with those of Europe and America as Regards Strength and Other Properties. By C. W. Scott. *Paper No.* 3, *Assoc. of Engineers in Burma.* Pp. 17, 9½ × 6½. (Rangoon: Rangoon Times Press, 1931.)

Les Bois Coloniaux au Musée des Colonies. *Rev. Bot. Appl. et d'Agric. Trop.* (1931, **11**, 158–163). Consists mainly of an alphabetical list of French colonial woods, with botanical name, place of origin, colour of the wood, density, principal uses and approximate annual production.

Tests on Timber Pit Props. By S. M. Dixon and M. A. Hogan. *Paper No.* 72, *Safety in Mines Research Board.* Pp. 82, 9¾ × 6½. (London: H.M. Stationery Office, 1931.) Price 2*s*.

Wood-liquid Relations. By L. F. Hawley. *Tech. Bull. No.* 248, *U.S. Dept. Agric.* Pp. 34, 9¼ × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1931.) Price 10 cents. Deals with wood structure; the absorption of water and other liquids by wood and the effect of water on the physical properties of wood; and the diffusion of water through wood.

Acetic Acid and Cellulose Acetate in the United States. A General Survey of Economic and Technical Developments. By E. P. Partridge. *Indust. Eng. Chem.* (1931, **23**, 482–498).

Gums and Resins

Turpentines from *Pinus radiata* and *P. pinaster*. By T. H. McCombs. *New Zealand Journ. Sci. and Tech.* (1931, **12**, 333–337). Preparation, properties and composition of the gum and wood turpentines from these trees.

Tanning Materials

Fiches Documentaires sur les Tanins de la France d'Outre Mer. *Actes et Comptes Rendues de l'Assoc. Col. Sci.* (1931, **7**, 129–138; 155–158; 177–179). An account of the following French colonial tanning materials and their cultural production and uses: wattle, mangrove, *Acacia arabica*, "Takaout" (galls formed on the tree *Tamarix articulata*), tara pods and tizerah bark. A final section deals with chrome tanning materials.

Sulla Concia coi Tara (*Caesalpinia tinctoria*) e sulla loro produzione in Italia e Colonie. By F. Vignolo-Lutati. *Bol. Ufficiale R. Staz. Sperimentale per l'Indust. delle Pelli e delle Materie Concianti* (1931, **9**, 297–303). The use of *Caesalpina tinctoria* pods for tanning and their production in Italy and its colonies,

Hirda (*Terminalia Chebula*) or Black Myrobalan. Information on Correct Methods of Collection, Preparation etc., and Propagation. *Indian Forester* (1931, **57**, 404–409).

Palétuviers de Madagascar, leur Écorces Tannifères. Écorces de "Honkovavy" (*Ceriops Candolleana* Arn.). By F. Heim de Balsac, A. Jamet and H. Heim de Balsac. *Bull. de l'Ag. Gén. des Col.* (1931, **24**, 1242–1259). A botanical description of the tree and its different parts, and analyses from the point of view of tanning material of the root, branches, wood and other portions of the tree.

NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

TEXTILE FIBERS AND THEIR USE. By Katharine Paddock Hess, M.S., Associate Professor of Clothing and Textiles, Kansas State College of Agriculture and Applied Science. Pp. xiv + 354, 8¼ × 5½. (Chicago, Philadelphia and London: J. B. Lippincott Company, 1931.) Price 10s. 6*d*.

This book, intended for college instruction, has been written with the object of imparting to the users of textile fabrics a sufficient knowledge of the characters and properties of fibres, of the methods of manufacture and simple methods of testing, to enable them to select and handle cloth intelligently and to form a correct judgment of the quality, durability and value of a fabric.

Consideration of the textile fibres is restricted to the five fibres of which most of our clothing and household fabrics are composed, viz. wool, silk, cotton, linen and rayon.

The work is accompanied by exercises and experiments designed for laboratory classes. Certain subjects, such as spinning and weaving, are described so briefly that it would be impossible to gain an adequate knowledge of them from reading the book alone, and presumably the student is expected to gain more detailed information in the classes and laboratory.

The book consists of three parts, of which the first deals with the construction of fabrics, the processes of finishing and dyeing, and the production of design, and gives a very brief survey of the various textile fibres and their classification.

The second part is concerned with wool, silk, cotton, linen and rayon, their production, characters and manufacture into yarns and fabrics, whilst the third part treats of factors influencing textile consumption, the selection of fabrics for clothing and household use, and the care of fabrics, including their laundering, cleaning and preservation.

The work is well illustrated and numerous references are provided for additional study.

JUTE 1931. Pp. 103, 10 × 7½. (London: The British-Continental Jute Press, Ltd., 1931.) Price 10*s.*

This work, which is printed in English and German in parallel columns, contains a large amount of information regarding jute, particularly from the commercial standpoint. Its object is to supply firms engaged in the jute trade with statistics and other data which may assist them in their work.

A short description is given of the methods of jute cultivation and the extraction of the fibre, together with a brief historical review of the development of the jute industry. The uses of jute and the machinery employed in the various manufacturing processes are dealt with, and the present position of the industry in different countries is described, the relevant statistics being provided. One section of the book deals with the many trade associations which have been established with a view to controlling and safeguarding the interests of certain sections of the industry.

The work includes an article on " Substitutes for Indian Jute," by F. I. Oakley, in which reference is made to various fibres which might take the place of jute if a shortage of the latter should be caused by failure of the Bengal crop or other circumstances. Some of these so-called substitutes resemble jute, and if they could be produced on a commercial scale would be very useful when jute is scarce. Other fibres are mentioned, however, which are too unlike jute to be used as a substitute except perhaps in times of great emergency. An unfortunate mistake appears in this article to the effect that Bombay hemps of which "the chief varieties are Dewghuddy, Sewney, Itarse and Philibit are all obtained from the plant *Hibiscus cannabinus*." It seems hardly necessary to point out that the Bombay hemps, like other varieties of Sunn hemp, are in fact derived from an entirely different plant, viz. *Crotalaria juncea*.

The book contains some good illustrations and should form a useful work of reference for those engaged in the jute industries. It is proposed to issue a new edition next year entitled *Jute 1932*, the value of which will be enhanced by the inclusion of a jute trade directory.

ANALYSIS OF LEATHER AND MATERIALS USED IN MAKING IT. By John Arthur Wilson, Sc.D., and Henry Baldwin Merrill, Ph.D. Pp. xi + 512, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1931.) Price 42*s*.

The importance of chemical analysis in the control of tannery operations receives steadily increasing recognition, and in consequence the tannery chemist is called upon to examine an extremely large variety of materials. Not only are leathers of the various kinds subjected to analysis at several stages of production, but examination of the raw materials and tannery liquors is also necessary. Both the authors are intimately acquainted with tannery chemistry, and the analytical methods which have been developed in their laboratories for more than thirty years are set forth together with the methods sponsored by official organisations and other authorities. To enable the chemist to understand the principles underlying each method and to avoid false conclusions when applying them, explanations and discussions are given of the various methods and the apparatus employed.

After a brief introduction, several chapters are devoted to skins and leather, the investigation of which includes microscopical and bacterial examination, chemical analysis and the determination of physical properties. Later chapters deal with the analysis of beamhouse materials and liquors, vegetable tanning materials, chrome tanning materials and liquors, fat liquoring and stuffing materials, and materials employed in dyeing and finishing.

The references to literature given at the end of each chapter, in some cases amounting to over a hundred, are a useful feature of the book. The work is valuable as being a comprehensive collection within one volume of the information required by the tannery chemist in the execution of his many and diverse duties.

THE MECHANICAL PROPERTIES OF WOOD. By George A. Garratt, M.F. Pp. ix + 276, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1931.) Price 17*s.* 6*d.*

Professor Record's well-known *Mechanical Properties of Wood* has been the *vade mecum* of students of wood technology since 1914. Recently, however, the book has gone out of print, and the present work was undertaken by the author at the suggestion of Professor Record. During the past seventeen years much work on the mechanical properties of wood has been carried out in the forest products research laboratories now established in several countries, and Mr. Garratt's new book is designed to afford an account of the present position of the subject. Record's book laid a sound foundation on which a much larger and practically new work has been built by the author, who gratefully acknowledges, however, that his sections dealing with mechanical properties and timber testing have been modelled on the treatment given to these subjects in the earlier work.

Part I of the new book describes, in a relatively simple manner, the relation of wood material to stresses and strains, and is followed by a section concerned with the factors which influence the mechanical properties of wood, such factors being grouped mainly as defects and agents other than defects. This latter subject is obviously of much practical importance and the author has taken pains to show the relation of the various factors to the technical usefulness of wood and its selection for special strength requirements. Part III is a consideration of the working stresses for structural timbers, such stresses being the unit strength values obtained from laboratory tests suitably adjusted to meet the conditions likely to be imposed on the material under actual service conditions. The factors involved in making these adjustments are considered for the structural grades of timber conforming to American lumber standards. Part IV describes methods of timber testing and, as stated above, is based on the corresponding section of Record's book.

The appendix forms a very useful part of the book. It discusses the factors concerned in formulating structural grading rules which have as their object the provision of means of selecting timber for strength, and uniformity of strength, for structural use, and forms a useful supplement to the chapter dealing with the influence of defects and other factors upon strength; it also provides a copy of "basic provisions for grading rules for structural timbers" adopted by the American lumber industry in co-operation with all organised timber-using industries. The book contains valuable series of bibliographies and will take its place as the standard work on the subject.

COLLOID CHEMISTRY: THEORETICAL AND APPLIED. By Selected International Contributors. Collected and Edited by Jerome Alexander. Volume III. First Series of Papers on Technological Applications. Pp. 655, 9 × 6. (New York: The Chemical Catalog Co., Inc., 1931.) Price $10.50.

This work is part of an important series, of which Vol. II (on Biology and Medicine) was mentioned in this BULLETIN (1929, **27**, 141). It consists, like the previous volumes, of a collection of separate papers by different authors; in this instance dealing, as the sub-title indicates, with the technological applications of colloid chemistry. The papers and the bibliographies which follow them should serve as a valuable guide to the highly specialised literature of their subjects.

CHEMISTRY, LIFE AND CIVILISATION: A Popular Account of Modern Advances in Chemistry. By Hubert T. S. Britton, D.Sc., D.I.C., F.I.C. Pp. vi + 248, 8½ × 5½. (London: Chapman & Hall, Ltd., 1931.) Price 10*s*. 6*d*.

From the preface it would appear that this volume is intended to be a popular exposition of chemistry as a factor in modern life: to be also of service to teachers; and to appeal to those " who already have some knowledge of the subject, but who wish to know something of the advances made in modern chemistry." It seems likely that in practice the book will be most useful in the first-mentioned way, i.e. for non-technical readers, who will find in it much instructive information on the applications of chemistry to such matters as agriculture, metallurgy and power generation, and on the chemical aspects of human physiology. It may, however, be suggested that in a future edition it might be well to omit some of the chemical formulæ and other highly technical details which (especially in Chapters II and III), are likely to confuse, and possibly to repel, many readers who would otherwise find the book of very considerable interest.

THE SOIL. By Sir A. D. Hall, K.C.B., LL.D., D.Sc., F.R.S. Fourth edition, revised and enlarged. Pp. xvii + 388, 8 × 5. (London: John Murray, 1931.) Price 9*s*.

During the eleven years which have elapsed since the previous edition of this book appeared, there have been enormous advances in various branches of knowledge having an influence upon the study of the soil. One direction of advance has been in the application of the increased knowledge of the behaviour of colloids to the understanding of the numerous physical and chemical processes taking place in the soil, such, for example, as the reaction of the soil with fertilisers. The technical methods of examination of the soil, especially the methods of mechanical analysis, have been completely revised and to a certain extent standardised during the last few years, largely owing, in this country, to the work of the Agricultural Education Association and of the International Society of Soil Science. In addition, extensive research has been carried on, particularly in Russia, which has led to the establishment of the science of pedology—the study of the soil in relation to its origin—as an independent science, not necessarily having a direct bearing on agriculture. Although the present volume deals with the soil mainly from the point of view of agriculture, it has nevertheless been necessary to take account of all this additional knowledge and consequently much of the text of the previous edition has had to be rewritten and new matter incorporated.

The book follows in the main the plan of earlier editions. There is a short introductory chapter dealing in general terms with some of the chemical, physical and biological factors involved in the study of the soil. This is followed by chapters on the origin, classification and mechanical analysis of the soil, and their relations with texture, tillage and cultural operations. The usual methods of chemical analysis of the soil are described in some detail, together with a discussion of the interpretation of the results obtained and their limitations. The succeeding chapters deal with the micro-organisms of the soil, especially in their relation to crop production, the absorption of fertiliser and other salts by the soil, the various causes and manifestations of fertility and sterility in soils, and methods of amelioration and reclamation of infertile soils. The final chapter gives an outline of the classification of soils and of the more important soil types found in this country.

The book is up-to-date and well written and should prove of great value to all those who are interested in the study of the soil as the basis of the production of crops.

PRINCIPLES OF STRUCTURAL GEOLOGY. By Charles Merrick Nevin, Ph.D. Pp. xi + 303, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1931.) Price 17*s.* 6*d.*

As its title implies, this book deals with the distortions and deformations of the earth, especially the crust, their cause and effect. This is a subject of very wide scope and about certain aspects of which many volumes have been written. The book is, however, very welcome because its aim is to serve as a simple summary rather than as an exhaustive treatise.

As is usual with such a subject, the effects are first described, and later the theories as to their causes are dealt with. Following a brief introduction, the descriptive portion is arranged in eight chapters which deal with physical properties of rocks, stress and strain relations, flexures, faults, joints, cleavage, structures in unconsolidated sediments, and the reflection of rock structure in the topography. Of these, the chapters on faults and flexures occupy the major part, in fact more than one-third of the book.

The last three chapters of the volume are devoted to facts, inferences and hypotheses regarding the earth, to a consideration of continents and ocean basins, and to mountain systems. These are subjects of absorbing interest to all students of geology, bearing as they do upon the very foundations of the science, and although of necessity the treatment of them here is merely a brief outline, sufficient matter is provided concerning such problems as the theory of isostasy, the permanence of oceans and the modes of mountain building, to give students a fair summary of the various opinions expressed by different authorities on these matters and the arguments for and against them.

The book is a well-compiled introduction to the subject of structural geology, written in a manner calculated to stimulate an ability to reason, and with an almost complete absence of dogmatic statement. Sufficient references are given to original papers to enable the student to pursue the subject further, and the volume is particularly well illustrated, a matter of much importance in discussing this subject. Examples chosen to illustrate the questions involved are taken from all over the globe, and the book should prove just as useful to English readers as to those in America for whom it was written.

HANDBOOK FOR PROSPECTORS. By M. W. von Bernewitz. Pp. xi + 359, 7¼ × 5. Second edition. (London: McGraw-Hill Publishing Co., Ltd., 1931.) Price 18*s*.

The issue of a second edition of this book within a comparatively short time shows that it has met a want. The author is well qualified for his task, for not only has he spent many years in practical mining and metallurgical work in many parts of the world, but also has had much experience in technical writing and in the gathering of technical information.

The book itself is an enlarged and corrected edition of the first issue, and its value has been increased by the addition of a well-condensed section on geophysical prospecting and its recent literature. Though the book has been largely adapted to suit the needs of the prospector in North America, yet with the addition of a small amount of local matter in each case it could be equally useful almost anywhere.

For the benefit of those who have not seen the first edition it may be said that the book is divided into four parts, the first of which deals with general information useful to prospectors, including equipment, food and transportation. The second part is devoted to the elementary knowledge required by a prospector of field mineral tests, geology, commercial ores and their deposits, sampling, preliminary development and marketing. The third part, in 165 pages, would be useful to many besides prospectors, as it gives a large amount of condensed information on over fifty industrially used metallic and non-metallic minerals.

The book is completed with an extensive glossary of mining and metallurgical terms and an index. It is fully illustrated, largely with the author's own sketches and diagrams, and is well printed on a stout paper which would stand much handling. It can be confidently recommended.

ELEMENTS OF OPTICAL MINERALOGY. An Introduction to Microscopic Petrography. By Alexander N. Winchell. Part I. Principles and Methods. Pp. xii + 248, 9 × 6. Fourth Edition, Revised and Enlarged. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1931.) Price 21*s*.

The fourth edition of Part I of this well-known text-book of optical mineralogy is essentially the same as the preceding edition, which was reviewed in this BULLETIN, (1928, **26**, 543). In consequence, however, of recent improvements in the methods for determining refractive indices by immersion liquids, valuable changes and additions have been made in the last chapter of this book dealing with special methods of study. These improvements involve not only modifications of the double variation method for measuring refractivity, but also a marked simplification in the use of the universal stage, and a short illustrated article on graphical methods for the improved universal stage by Professor R. C. Emmons, who is primarily responsible for all the above improvements. The latter article is accompanied by four folding plates (which for convenience are kept in a pocket inside the back cover) dealing respectively with: (1) graphical corrections of universal stage angles for the difference in indices of refraction of crystal and glass (after Fedoroff); (2) graphical calculation of crystal indices of refraction for known angular extrapolations within optical symmetry planes; (3) universal stage protractor (after Fedoroff); (4) relations between optic angle and principal birefringences (after F. E. Wright). These plates have undoubtedly added materially to the cost of the present work, and explain, in part at least, the increase in price over the preceding edition, which was published at 17*s.* 6*d.*

The book is an admirable and up-to-date treatise on the principles and methods of optical mineralogy, and the fact that four editions have been called for within the past ten years is a tribute both to author and publisher alike.

A MANUAL OF DETERMINATIVE MINERALOGY WITH TABLES FOR THE DETERMINATION OF MINERALS. By J. Volney Lewis. Fourth edition, revised by A. C. Hawkins. Pp. ix + 230, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1931.) Price 18*s.*

This useful manual is a revision by Dr. Alfred C. Hawkins of the preceding edition published some ten years ago, and noted in this BULLETIN (1922, **20**, 137–138).

The principal changes that have been effected in the present work are: (1) a considerable reduction of repetitions in determinative tables of minerals by means of their physical properties; (2) the elimination from the blow-pipe tables of a number of rare mineral species; and (3) the addition of a chapter on optical methods.

The revision has undoubtedly enhanced the value of the work, which will doubtless be fully appreciated by students, for whom it is primarily written.

SPECTRUM ANALYSIS IN MINERALOGY. By A. A. Fitch, A.R.C.S., D.I.C., Ph.D., F.G.S. Pp. 52, 9¾ × 6¼. (London: Adam Hilger, Ltd.) Price 1*s.* 9*d.*

This book summarises succinctly the methods and results of spectrum analysis as a means of identifying mineral species and investigating their chemical composition.

In addition to the valuable descriptions of the technique required, brief notes are given of the qualitative and quantitative emission spectra analysis of minerals, mineral concentrates, rocks, meteorites and natural waters, while mention is made of the highly specialised technique that is required for X-ray spectrum analysis. The methods involving the use of absorption spectra for mineral analysis are also described, the author observing that the spectroscopic eye-piece or micro-spectroscope (the spectroscope most familiar to the mineralogist, and often used for the recognition of cerium in monazite and related minerals) could be used much more frequently for mineral analysis if full use were made of the valuable tables published by E. T. Wherry. The work is completed by a tabulated statement of results of spectroscopic analysis of 756 minerals, and a comprehensive bibliography containing 91 references.

The book is a valuable review of the scattered literature on the subject, and should prove of considerable interest to those engaged in the scientific study of mineralogy.

FARADAY AND HIS METALLURGICAL RESEARCHES. By Sir Robert A. Hadfield, Bt., D.Sc., D.Met., F.R.S., F.I.C., M.Inst.C.E. Pp. xx + 329, $9\frac{3}{4} \times 6\frac{1}{4}$. (London: Chapman & Hall, Ltd., 1931.) Price 21*s*.

This book gives a full account of a branch of Faraday's work which has been generally passed over in a few words by his previous biographers.

The first systematic research undertaken by Faraday at the Royal Institution was the examination of steels with a view to their improvement by the addition of various other elements, and although no immediate practical application of his results was made, they formed the foundation for much of the later work which has been carried out on alloy steels.

The author has recently been able to submit the specimens prepared by Faraday to a very full chemical and physical examination in the research laboratories of Messrs. Hadfield Ltd., Sheffield. A detailed record of these experiments and of the results obtained is given and it is shown to what extent Faraday anticipated subsequent research.

The book is not solely an account of Faraday's work on steels, but full details have been collected showing how he first became interested in the subject, the people with whom he was associated in the course of his work, and the state of metallurgy in his time.

The concluding chapter gives a survey of late developments in the manufacture of alloy steels in which the author's firm has played such an important part.

The book is extremely readable, and should be of great interest, not only to those who have become better acquainted during the last year with the ubiquity of Faraday's researches, but also to those concerned more particularly with steel and steel-making alloys.

STAINLESS IRON AND STEEL. By J. H. G. Monypenny, F.Inst.P. Second and revised edition. Pp. ix + 575. $9\frac{3}{4} \times 6\frac{1}{4}$. (London: Chapman & Hall, Ltd., 1931.) Price 25*s*.

This is a second edition of Mr. Monypenny's treatise on Stainless Iron and Steel, the first edition of which was reviewed in this BULLETIN (1926, **24**, 364).

Progress in the metallurgy of stainless steels has been so rapid and extensive in the five years which have elapsed since the publication of the first edition, that the present volume is almost unrecognisable as a second edition of the same work. It has expanded from 304 to 575 pages, and may be said to have been almost entirely rewritten. Its scope has been considerably increased, and a long additional chapter on the influence of other alloys on the properties of high chromium steels has been included. Other chapters have been modified, and amplifications have been made to their subject-matter.

There is no need, however, for modifications, other than amplification, of the appreciative remarks which were made concerning the earlier edition of this work. It treats thoroughly and carefully with a subject of vast importance, and the increasing use of stainless steels for many industrial purposes is sufficient evidence of the necessity for a book which deals in such a readable manner with their characteristics and treatment.

THE PREPARATION, SELECTION AND DISTRIBUTION OF COAL. Pp. viii + 182, 9 × 6. (London: Industrial Newspapers Ltd., 1931.) Price 5*s*.

During the winter of 1929–1930 two series of lectures on the subjects of this book were delivered under the auspices of the Coal Trade Luncheon Club. A demand for the publication of the lectures resulted in the present volume, which was issued with the collaboration of the Institute of Fuel. The assistance of the Fuel Research Staff of the Department of Scientific and Industrial Research, as well as of the Coal Merchants Federation of

Great Britain was also invoked. Moreover, it has been edited by a committee of experts.

The book is divided into six chapters, some of which have been divided into subsections, each of which has been written by a master of his subject.

The chapters are classified under:

(1) Geological—the formation of the Coal Measures; the different varieties of coal and the chief British seams; analyses and inferences made from them;
(2) Mining of coal with its principles and methods;
(3) Preparation for the market;
(4) Transport by sea, rail and road;
(5) Utilisation, including domestic and industrial uses, carbonisation (almost entirely on the high-temperature variety); anthracite; gas-producer practice;
(6) Salesmanship.

The book contains a very large amount of carefully selected information written in an extremely simple style; it is also well illustrated with photographs and diagrams. With these considerations and its low price it should make a wide appeal to all classes of readers.

WATER DIVINERS AND THEIR METHODS. By Henri Mager. Translated from the fourth edition of "Les Sourciers et leurs Procédés," by A. H. Bell. Pp. x + 308, 8¾ × 5½. (London: G. Bell & Sons, Ltd., 1931.) Price 16*s*.

The author of this book is stated by the translator in his preface to be the greatest living expert in its subject, and from a perusal of the work it would appear that this is very probably the case. One is also drawn to the conclusion that the French have made most extraordinary progress in the art of dowsing and have raised it to the position of a science. So great is the enthusiasm for the subject in France at the present time that a society is devoted to its study and a monthly journal is published.

The book is divided into two parts, the first being mainly historical, dealing with dowsing from the earliest times up to the present, and the individual methods employed by a large number of observers and the results obtained, the author quoting failure as well as success. He gives, incidentally, an account of the very exhaustive tests of the powers of some twenty well-known dowsers, who in 1913 carried out a series of tests devised by, and under the control of, the Second International Congress of Experimental Psychology, with results which would appear almost incredible to the ordinary man. A further series of tests were successfully made in 1923.

The second part of the book deals mainly with the highly scientific modern developments of dowsing and the improved apparatus used. The author claims that nowadays the dowser, who has become an "hydrologist," must be infallible in being able to (1) pick up and identify the "fields of force" connected with subterranean streams, mineral deposits, subterranean galleries, faults, bedding planes, foundations of walls, etc., (2) to mark out on the ground the course of an underground stream and determine its direction of flow—distinguishing it from a metallic vein—or to outline a sheet of water, (3) to be able to say if the water is "rising" from fissures or "descending" from infiltration—a point important on the question of potability, (4) to establish the depth at which water occurs and the amount of its flow or pressure.

The author states that the geologist, unless he follows in the dowser's tracks and uses the detectors (described in the book), possesses no means of investigation; he can only form theories, whilst the hydrologist can arrive at exact conclusions. He mentions useful investigations he himself has carried out, which include the mapping of (1) the underground streams in the town of Tunis; (2) the subterranean waters of the sheet of plastic clay in the Bois de Boulogne, Paris; (3) the thermal radio-active streams of the Aix-en-Provence district; (4) the courses of the artesian waters in the greensand of the Paris area.

The author, with another dowser, M. Charié, has surveyed hundreds of covered-up military saps and excavations left after the war in Pas-de-Calais, Nord and Somme, the mapping of which has been of great assistance to architects and others.

The book, which is replete with information, is fully illustrated and well produced and is well worth careful study, especially by many who live in the drier parts of the British Empire.

HYDRO-ELECTRIC DEVELOPMENT IN THE BRITISH EMPIRE. By John E. Robbins, M.A. Pp. xix + 143, 7½ × 5. (Toronto: The Macmillan Company of Canada, Ltd.; London: Macmillan & Co., Ltd., 1931.) Price 5s.

At the present time, especially when ways and means are being considered for the development of the different parts of the British Empire, the publication of such a book as this is very opportune. It is the result of the first of a series of researches on Empire Economic Development to be carried out at McMaster University, Hamilton, Ontario, and financed by a former graduate, Mr. C. E. Eaton. As four-fifths of the Empire's water-power utilisation has taken place in Canada, it is eminently fitting that such an investigation should be made in that country.

Enormous progress in the use of hydro-electric power has taken place in the world during the present century, and with its projected extensions it is ever growing with the increasing demands of industry. Moreover, there are large resources not yet tapped in the Empire itself. The possibility of using long-distance transmission has greatly increased the possibility of using these resources.

The book gives in an extremely compact form virtually all that is known about water power, actually in use or potential, in all the principal countries of the Empire, Canada with its wealth of published information naturally being dealt with in much detail. The various sections of the book are supplied with maps of the chief water-power areas and bibliographies of all the important recent publications available. It is an excellent *vade mecum* on its subject, and should be in the hands of all interested in natural power development.

BOOKS RECEIVED FOR NOTICE

MODERN INDIA. A Co-operative Survey. Edited by Sir John Cumming, K.C.I.E., C.S.I. Pp. vi + 304, 7¼ × 5. (Oxford: The University Press; London: Humphrey Milford, 1931.) Price 3*s.* 6*d.*

REGIONAL SURVEY AND ITS RELATION TO STOCK-TAKING OF THE AGRICULTURAL AND FOREST RESOURCES OF THE BRITISH EMPIRE. By Ray Bourne, M.A. Pp. 169, 10¾ × 7½. (Oxford: The Clarendon Press, 1931.) Price 15*s.*

BAILLIÈRE'S ENCYCLOPÆDIA OF SCIENTIFIC AGRICULTURE. Edited by Herbert Hunter, D.Sc. In two volumes. Pp. xvi + 1361, 9½ × 6½. (London: Baillière, Tindall & Cox, 1931.) Price 63*s.*

THE COCONUT. By Edwin Bingham Copeland. Third edition. Pp. xviii + 233, 8½ × 5½. (London: Macmillan & Co., Ltd., 1931.) Price 20*s.*

LE RICIN: BOTANIQUE, CULTURE ET COMMERCE. By Ph. Eberhardt. Pp. 136, 10 × 6½. Third edition. (Paris: Société d'Éditions Géographiques, Maritimes et Coloniales, 1931.) Price 20 francs.

FATS AND OIL STUDIES OF THE FOOD RESEARCH INSTITUTE, STANFORD UNIVERSITY, CALIFORNIA. No. 4, December, 1930. MARGARINE AS A BUTTER SUBSTITUTE. By Katharine Snodgrass. Pp. xiv + 333, 8¾ × 5¾. (California: Food Research Institute, Stanford University; London: P. S. King & Son, Ltd., 1930.) Price 12*s.*

CONGRÈS INTERNATIONAL DES FABRICANTS DE CHOCOLAT ET DE CACAO, ANVERS, 1930. Volume Preparatoire. Pp. 384, 9¾ × 6¼. Price 150 francs belges (30 belgas). Compte rendu Officiel. Pp. 226, 9¾ × 6¼. Price 100 francs belges (20 belgas). (Brussels: Office International des Fabricants de Chocolat et de Cacao.)

WOOL QUALITY. By S. G. Barker, Ph.D., D.I.C., F.Inst.P., M.I.Chem.E., F.R.S.E., F.Z.S., F.T.I. Pp. 333, 9¾ × 7¼. (London: His Majesty's Stationery Office, 1931.) Price 21*s.*

THE USE OF FERTILISERS IN TROPICAL AND SUB-TROPICAL AGRICULTURE. By A. Jacob, Ph.D., and V. Coyle, M.Sc. Pp. 272, 8½ × 5½. (London: Ernest Benn Limited, 1931.) Price 10*s.* 6*d.*

IMPROVEMENT OF WOODLANDS. By W. E. Hiley, M.A. Pp. viii + 250, 7¾ × 5¼. (London: Country Life, Ltd., 1931.) Price 10*s.* 6*d.*

INTERNATIONAL ADDRESS BOOK OF BOTANISTS. Pp. xv + 605, 8½ × 5½. (London: Baillière, Tindall & Cox, 1931.) Price 12*s.* 6*d.*

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